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Science and Invention

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HOW TO BUILD A BURIED TREASURE FINDER

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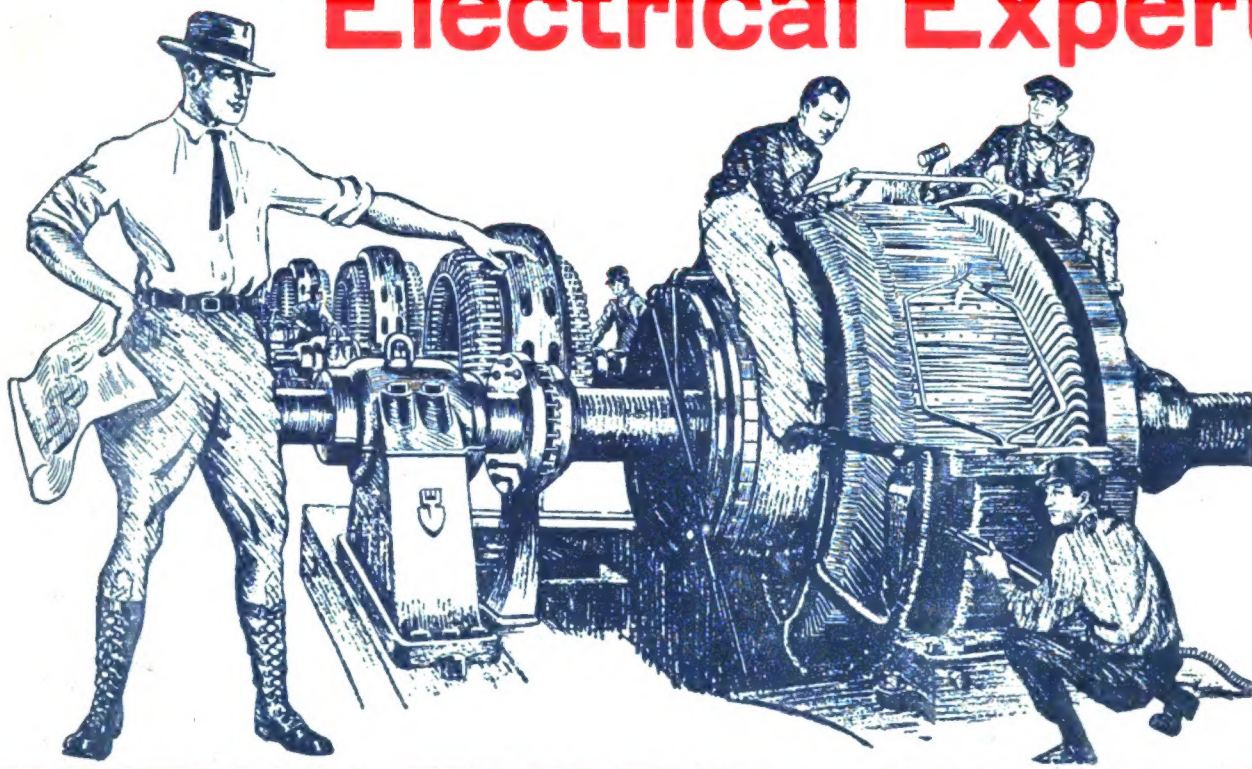

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Vol. IX
Whole No. 100

Science and Invention

FORMERLY

ELECTRICAL EXPERIMENTER

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August, 1921
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Publishers of SCIENCE & INVENTION and RADIO NEWS

Wonders of Wireless

THE radio art is now less than thirty years old, and if anyone had predicted, when Marconi made his historic experiments, that we were to have all the radio wonders that abound about us today, he would have been denounced as a fool, or perhaps considered as an applicant for the psychopathic ward. From sending wireless telegraph messages we progrest to the wireless telephone, then to sending pictures by wireless. It is now possible to do the following, which are not by any means stunts, but which enter into our everyday lives.

A detective can board a railroad train and in order to make sure of his suspect, he can talk back and forward to headquarters by wireless.

You can take a small suitcase with you in your automobile or motor-boat, and receive dance-music or radio telephone messages en route to your heart's content.

A captain far out at sea, with his trans-Atlantic steamer lost in a dense fog, may within five minutes ascertain his position by the radio-compass, which, as a matter of fact, is now done every day.

Or, the passenger on board ship may radio-telephone to the nearest land station, which connects with the land wireless stations, and thus it is possible to talk to anyone on the continent direct from the ship.

A recent development makes it possible for a physician on shore to listen to the heart-beat of the patient on a ship several hundred miles away, and make his diagnosis accordingly—a truly marvelous achievement. Diagnosis by wireless, between ship and shore, is an everyday procedure now, and physicians are becoming quite accustomed to it.

Then witness the recent experiments of the United States Navy with a radio-controlled battleship at sea which was guided solely by the mysterious waves with no one on board to steer the ship. Theoretically it is possible thus to send a ship across the Atlantic Ocean without any trouble today, and there is an even chance that freight vessels may be thus steered in the near future across the eastern and western seas.

Thanks to John Hays Hammond, Jr., we have already the radio-controlled airship, which has been adopted by the United States Government. By this means it becomes possible not only to steer the airship in any direction, but to drop bombs accurately on an enemy at will.

Sending radio-messages thru the ground or under the sea is now an everyday affair as well, while in Switzerland certain towns are setting and regulating all their clocks by radio. What then are the coming wonders of wireless? We may safely predict a few which may sound just as wild today, as those quoted above would have sounded twenty-five years ago.

Within a comparatively short time, transmission of power by radio will be made possible. This already has been accomplisht in the laboratory, and Dr. Nikola Tesla has predicted it for a long time, and it is bound to come. As soon as this is accomplished, we will probably not be far off from the day, when all sorts of matter will be sent by radio, wild as this prediction may seem today. We will be able to send a carload of coal thru the ether the same as we send a message to-day. We will send crude petroleum or benzine for a thousand miles and receive it at the other end.

We will be able to witness the future Dempsey-Carpentier fight a thousand miles away with our own eyes, by radio, while out at sea. In other words television by radio will be an accomplisht fact.

These are only a few predictions, and we could go on at will making many more, but we are deterred by lack of space.

H. GERNSBACK.

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Volume IX
Whole No. 100

Science and Invention

H. GERNSBACK,- EDITOR
H. WINFIELD SECOR.-ASSOCIATE EDITOR
T. O'CONOR SLOANE, Ph.D.-ASSOCIATE EDITOR

AUGUST
1921
No. 4

The Movies of the Future

DR. HENRY D. HUBBARD, Assistant Director of the United States Bureau of Standards, Washington, D. C., recently gave a wonderfully vivid presentation of the future development awaiting the moving picture industry, and we have illustrated some of his suggestions or rather predictions, for Dr. Hubbard holds that these things will come about in the next thirty years.

We see a newsboy selling movie newspaper reels to a customer. These contain the latest news and are to be carried home by the paterfamilias and exhibited in the home library, from a little home projector, as is also shown above. Another home use, according to Dr. Hubbard, will be the teaching of piano lessons. The hands of a skillful performer will be filmed and projected at any speed desired on a platinized sheet of glass, sustained obliquely above the keyboard of the piano, so as to form a camera lucida. The pupil will simply have to make his hands follow the motion he sees on the platinized glass.

It is not enough to learn to play the piano. Children have to be taught how to dance. The motions of the feet of a skillful dancer will be caught on the film, and will be projected up vertically against a ground glass floor, and the pupils will have a living picture to guide their feet in the intricacies of the dance of coming generations. The movies may even be made to supply a picture of the dancer's partner, or teacher, as a further guide to his movements as illustrated in the central cut.

We now come to the theater. Here it is perfectly obvious that the most needed improvement is vocalization, so that the movies need no longer be called, "the silent drama." It is all a question of synchronism, so that sound will accompany the proper opening and closing of the actor's lips.

But this is not all. The incidental music should be produced automatically. There are other sounds, however; and we now miss in the inspiring cavalry scene the tremendous thunder of the horses' hoofs; the great express engine and train of Pullmans rolls across the screen in deadly silence, while the Ford is as silent as the Rolls-Royce. Dr. Hubbard predicts that these sounds will eventually be produced automatically and synchronizing with the views upon the screen. In a rain storm we should hear the falling drops; in a tempest the rush of the wind should address itself to the ears, and the coals or

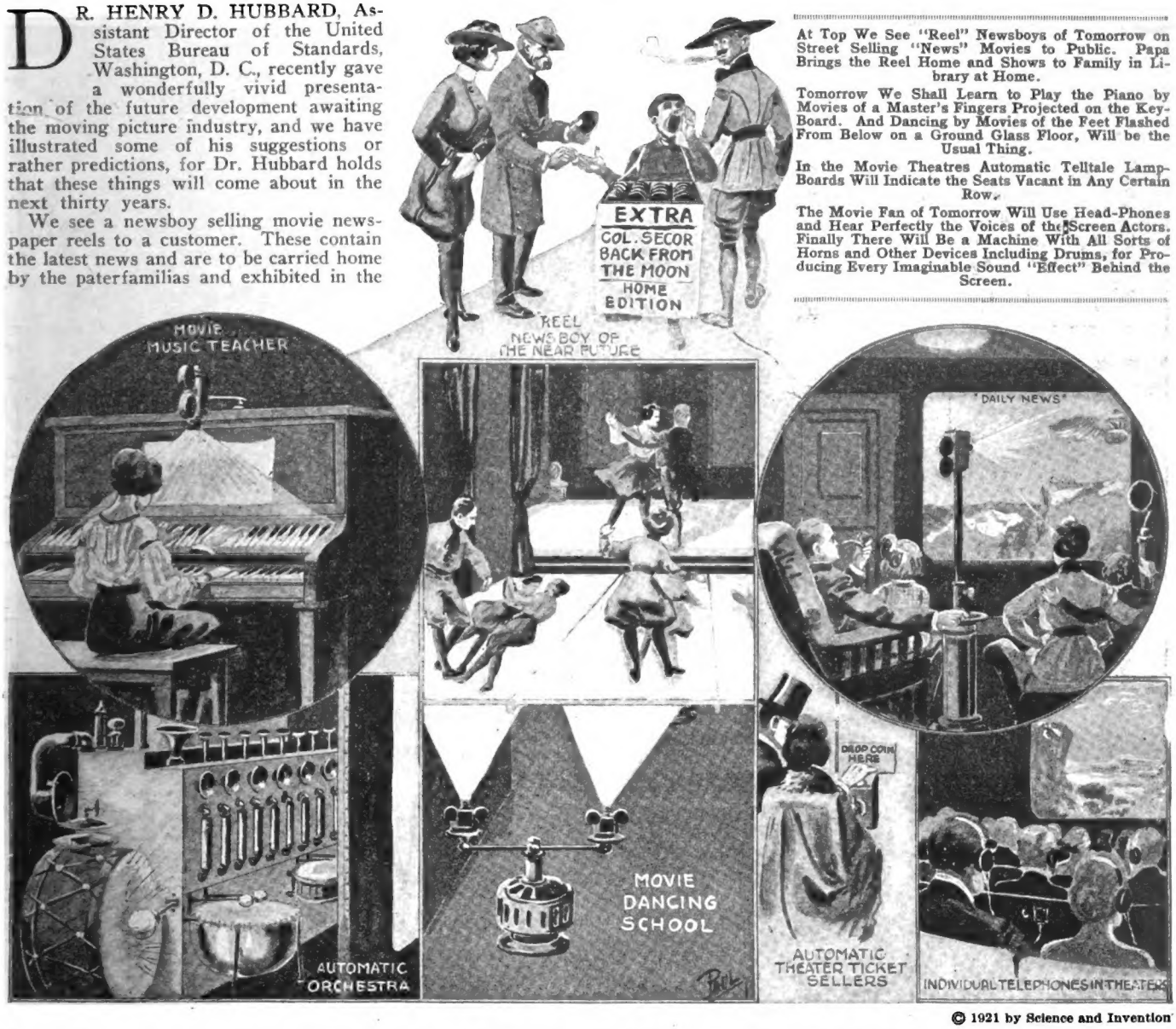
(*Continued on page* 354)

At Top We See "Reel" Newsboys of Tomorrow on Street Selling "News" Movies to Public. Papa Brings the Reel Home and Shows to Family in Library at Home.

Tomorrow We Shall Learn to Play the Piano by Movies of a Master's Fingers Projected on the Key-Board. And Dancing by Movies of the Feet Flashed From Below on a Ground Glass Floor, Will be the Usual Thing.

In the Movie Theatres Automatic Telltale Lamp-Boards Will Indicate the Seats Vacant in Any Certain Row.

The Movie Fan of Tomorrow Will Use Head-Phones and Hear Perfectly the Voices of the Screen Actors. Finally There Will Be a Machine With All Sorts of Horns and Other Devices Including Drums, for Producing Every Imaginable Sound "Effect" Behind the Screen.



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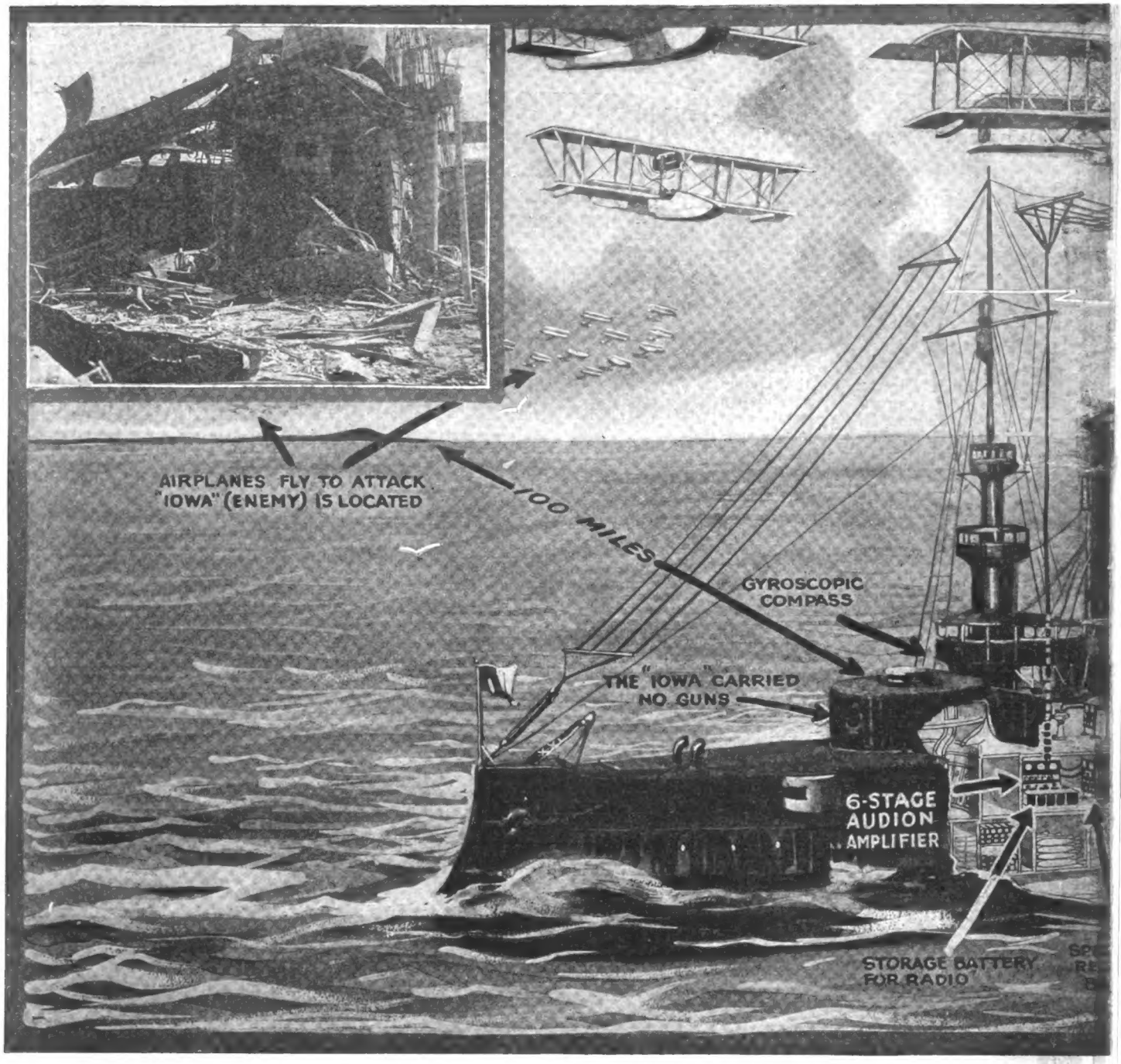
AIRPLANES FLY TO ATTACK "IOWA" (ENEMY) IS LOCATED
100 MILES
GYROSCOPIC COMPASS
THE "IOWA" CARRIED NO GUNS
6-STAGE AUDION AMPLIFIER
STORAGE BATTERY FOR RADIO

Airplane or Battleship—Which?

By GRASER SCHORNSTHEIMER

(ASSOCIATE MEMBER U. S. NAVAL INSTITUTE)

The Fight Between the Airplane and Battleship—Tests Which Will Decide our Future Military and Naval Policies

"IT isn't the shots you fire, but the shots that hit, that count." This is the reason why our wise and service seasoned Secretary of the Navy ordered that the bombing of the old battleship "Iowa," with dummy bombs, to ascertain the probabilities of hits, be conducted from an altitude of at least 4,000 feet. It is a wise and carefully thought-out order, for it is claimed, and to a great extent it has been proved, that an airplane can be driven off by anti-aircraft fire while at a height of no less than 6,000 feet.

Of course, this is based on naval anti-aircraft fire. The naval anti-aircraft battery usually consists of four, 3 inch, 50 caliber, anti-aircraft guns on high-angle mounts. With an efficient gun crew for each gun, and gun pointers who can shoot birds on the wing, such a battery can drive off any attack of bombing planes flying at an altitude of 4,500 feet or less. Of course, there are some who will want to contradict this; and their contradiction can only come thru the actual facts in the case. Never has an air attack on a battleship been successful, altho it has been tried many times.

An officer who was abroad with one of our battleships operating with the British Grand Fleet, during the latter part of the war, and who was in command of his ship's anti-aircraft battery, tells me that a German bombing attack was easily driven off, before it reached an altitude of 8,000 feet above our vessels. The Germans were always the premier bombers. What they bombed they usually "got." Everyone knows that. Then again, the Allies forced the Turks to ground their battle-cruiser, "Sultan Selim," formerly the German cruiser "Goeben," at the Dardenelles, during a naval action. British, French, Italian and Greek planes in great numbers bombed her for hours *without results*. The Turks were able to get her off and back to Constantinople, and since she has been surrendered, it has been found that, if she was ever hit, there are no marks or ill effects of it. The reason is plain: the anti-aircraft fire of the Turks was so good that the Allies could not get within accurate bombing range.

In theory the workings of anti-aircraft range-finding and fire-control are about the slowest and worst systems ever conceived by a human brain. They are difficult,

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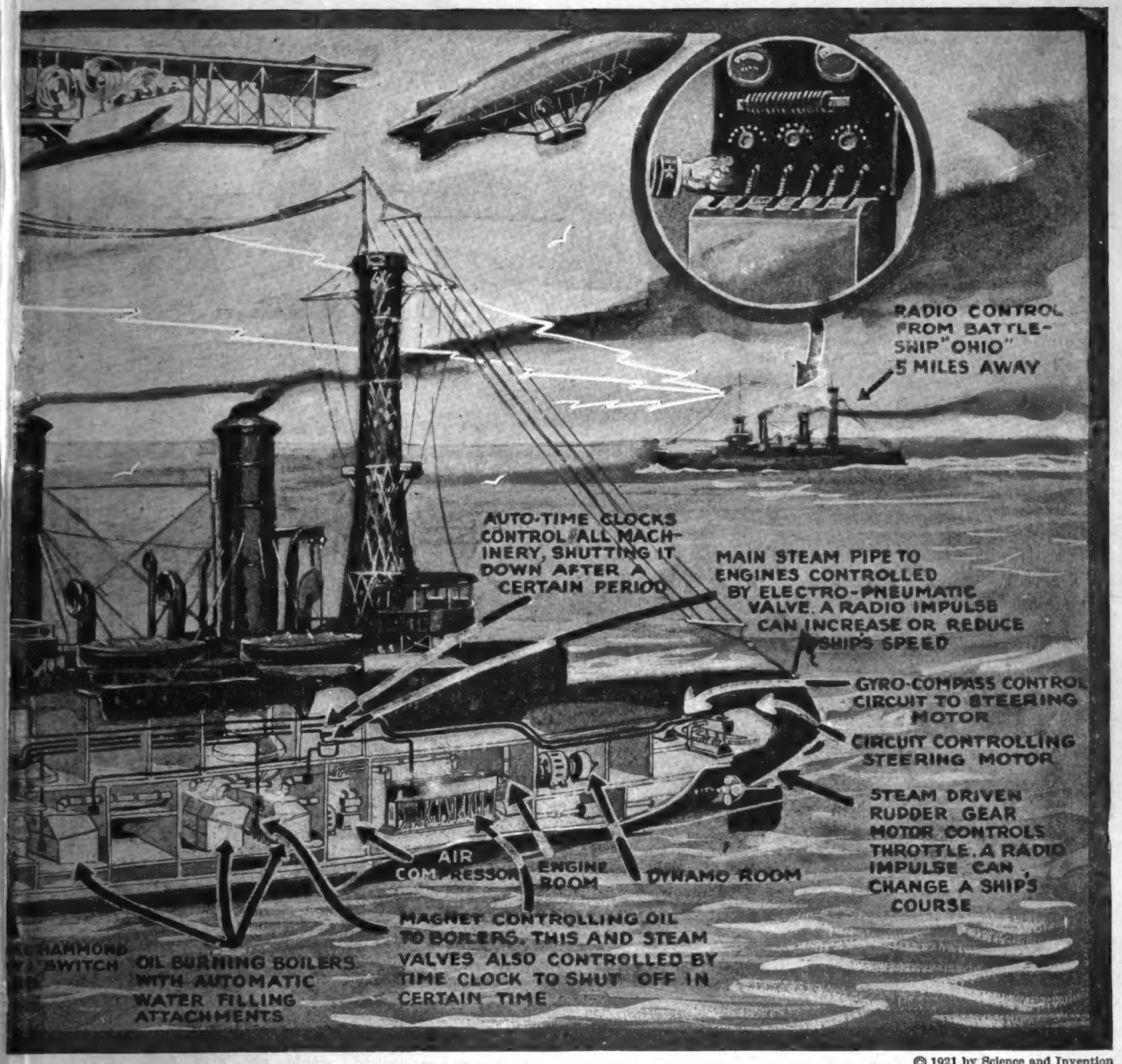
RADIO CONTROL FROM BATTLE-SHIP "OHIO" 5 MILES AWAY
AUTO-TIME CLOCKS CONTROL ALL MACHINERY, SHUTTING IT DOWN AFTER A CERTAIN PERIOD
MAIN STEAM PIPE TO ENGINES CONTROLLED BY ELECTRO-PNEUMATIC VALVE. A RADIO IMPULSE CAN INCREASE OR REDUCE SHIPS SPEED
GYRO-COMPASS CONTROL CIRCUIT TO STEERING MOTOR
CIRCUIT CONTROLLING STEERING MOTOR
STEAM DRIVEN RUDDER GEAR MOTOR CONTROLS THROTTLE. A RADIO IMPULSE CAN CHANGE A SHIP'S COURSE
AIR COMPRESSOR
ENGINE ROOM
DYNAMO ROOM
MAGNET CONTROLLING OIL TO BOILERS. THIS AND STEAM VALVES ALSO CONTROLLED BY TIME CLOCK TO SHUT OFF IN CERTAIN TIME
HAMMOND SWITCH
OIL BURNING BOILERS WITH AUTOMATIC WATER FILLING ATTACHMENTS

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The Sectional View of the Radio Controlled Battleship "Iowa" Shown Above Will Give a Clear Idea as to How Radio Impulses Were Transmitted from the Battleship "Ohio" Five Miles or More Away. Special Radio Receiving Apparatus With Powerful Audion Amplifiers and Hammond Selective Relays, Served to Control the Amount of Oil Passing into the Burners Under the Steam Boilers and the Direction Taken by the Ship Was Changed by Altering the Position of the Rudder by Radio. Time Clocks Were Connected With the Main Electro-Pneumatic Valve Relays, so That After a Certain Time the Steam to the Engines Would Be Shut Off as Well as the Oil Supply to the Boilers, if for Any Reason the Radio Control System Failed to Operate Properly. A Steady Course Could Be Maintained by the "Iowa" by Virtue of the Master Gyroscopic-Compass, and Control of the Ship Taken Away From This Compass at Any Time by Transmitting Certain Radio Impulses From the "Ohio." Inset Photo on Page 308 Shows Effect of Bomb on the "Indiana."—U. S. Navy Photo.

puzzling and entirely unreliable. The plane can change its speed, elevation and direction practically at will. For this reason, in the opinion of the writer, anti-aircraft gunnery can never be set to rule; it will always have to follow the "rules" of wing shooting. But these are no reasons why it should not be effective.

On the other hand the aircraft enthusiasts claim, that they can destroy any warship, and the crew in almost no time at all, with their explosive and gas bombs. They could but for one "if"—IF they could be allowed to drop their bombs from an altitude, low enough to insure a hit. A short time ago the Navy performed an experiment with the old battleship "Indiana." At high altitudes the planes could not hit, even tho they were undisturbed by anti-aircraft fire. At very low altitudes at which the planes dropping the bombs could not have existed in a real action, because of anti-aircraft fire, they destroyed the ship.

It is just this, that must be decided by these tests. The British were the first to feel the entrance of the plane into active naval operations, but now they put their money and confidence in four new battleships to cost over $50,000,000 each. The Japanese were badly bitten by the same idea—that the airplane was infallible—now they are building the largest and most powerful capital ships ever known to man. The French were quite upset by it. Now they intend to build capital ships. Here are some results. While the United States is the last to be struck by the idea, she has probably been more profoundly impress with it, than has any other nation.

Spotting and scouting are the primary uses of the naval plane, the bombing planes meriting little consideration, because of their inability to hit their targets from reasonable altitudes. However, it has been unquestionably proven, that aviation governs the naval situation to a great extent today. It would be the worst kind of folly for a fleet to go into action with an enemy, without first securing the control of the air. It has been said that with airplanes for spotting purposes, the gunnery efficiency of a ship is increased as much as thirty per cent. The ability of a ship to "hit" is the sum and total of the ship's efficiency. The ability of a number of ships to hit is a fleet's efficiency. The efficiency of the fleets is the Navy's competence and, upon the ability of the Navy to defend, lies the nation's safety.

Because of the failure of the bombing plane in naval aviation, another type, designed with the same general intent, came into existence. This type is the torpedo plane. The British have taken all bombing planes from their aircraft carriers and replaced them with Sopwith, "Cuckoo" type, torpedo-planes. However, the difficulty with the torpedo-plane is with the torpedo. During the war the torpedo so disappointed the Germans, as to ruin their

(*Continued on page 379*)

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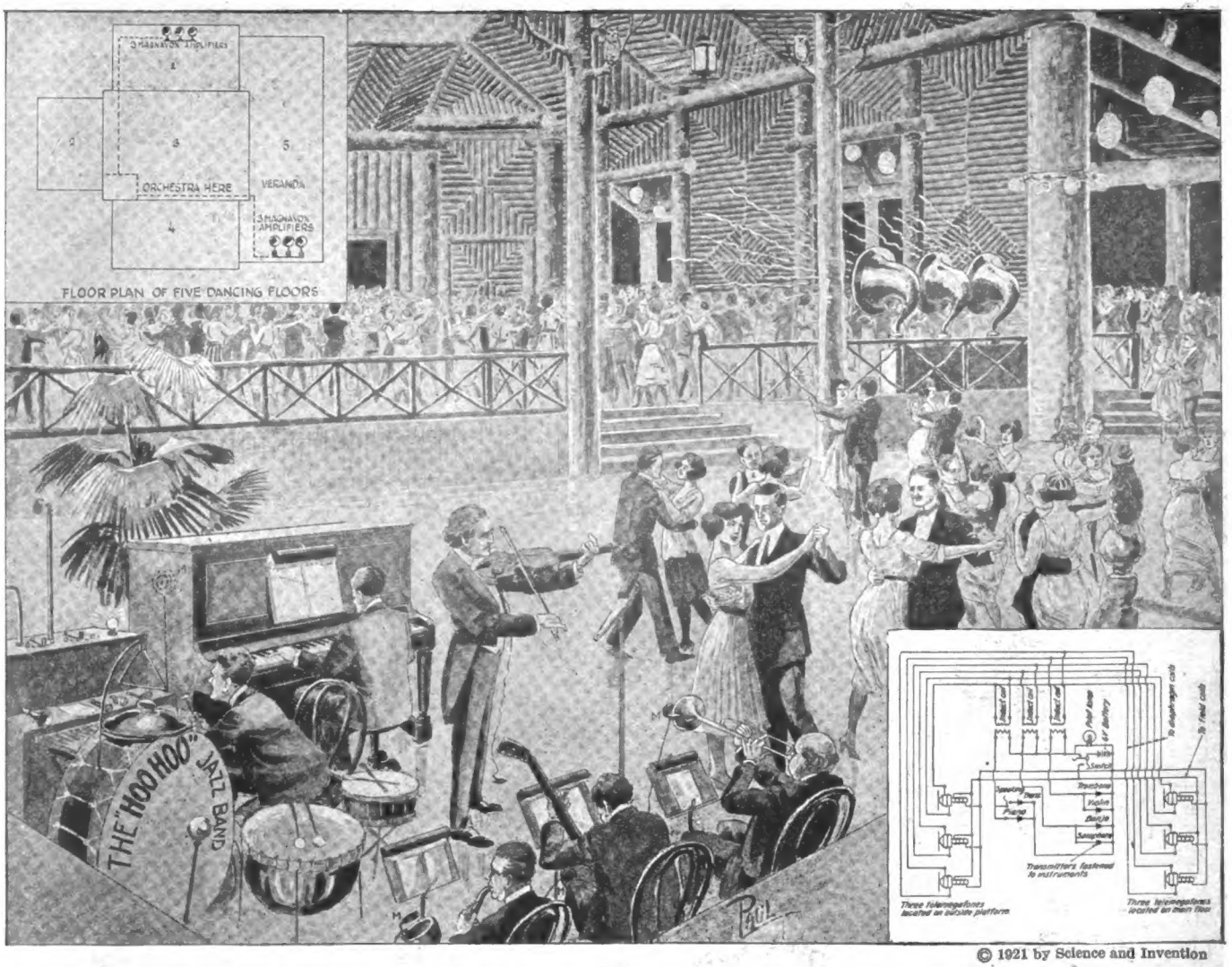

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This Shows a Corner of the Famous "Hoo Hoo" House Which Visitors to the Panama Pacific Exposition Will Remember for Its Novelty, the Building Having Been Erected from Woods Taken from the Large Trees of California. The "Hoo Hoo" House Was Recently Purchased and Moved to a Location Near San José, California, and Has Been Converted into a Great Dancing Resort. By Means of Loud-Speaking Telephone Amplifiers, the Music of the Jazz Orchestra Is Distributed Over the Five Large Dancing Floors, Including the Veranda.

One Orchestra for Five Dancing Floors

AT the Panama Pacific Exposition, there was an interesting building erected for the lumbermen of the country, called the "House of Hoo Hoo," after the name of the Lumbermen's organization. After the exposition closed, this building was moved in its entirety to a ranch in Santa Clara County, near San José, California. Here the Santa Clara Land Company re-erected it, waxed its floors, decorated it, and held dances there for the benefit of San José people, and the students of Stanford University, only a short distance away at Palo Alto.

A jazz orchestra, composed in its makeup of all-Stanford students, furnished the music and rapidly the *Hoo Hoo House* became known far and wide as a most popular dance floor.

It was soon found, however, that on Saturday evenings, when all five floors were crowded, there was not enough music to go around, and supply all the five floors. Mr. Hensley, the enterprising manager, knowing of the existence of the new telephonic loud-speakers, approached the makers of these instruments, and their engineers were sent

How the Telephonic Loud-Speaker Solved the Problem

down to see what could be done in the way of spreading out the music of the available orchestra, so that there would be plenty for all on all five floors.

After a series of tests which were conducted while the dancing was going on, a large permanent installation was decided on, with all wiring fished thru the walls and installed exactly as would be the electric lights, as shown in circuit in figure 1. Six large telemegafones were used in all, three on the inside and three covering the outside veranda, which has since been roofed over.

It was manifestly impossible to place five four button transmitters in parallel all leading into the same horn. Even were single button transmitters used, it would be found that to try and mix five different instruments through the same output horn, with series transmitter, would not give good results. Also it would not have been possible to give each instrument its proper tonal and volume value if the transmitters were in parallel, so an entirely different scheme was used.

The piano being the predominant instrument, carrying as it does most of the accompaniment, one four button transmitter was attached to the sounding board of the piano, leading thru its own induction coil to two horns, one inside and one out. This gave one of the group of three at each point entirely to piano music. The violin and trombone were placed in one circuit, and the saxophone and banjo on another circuit, in order that there might be as much difference as possible in the tonal quality of the instruments played thru the same transmitter circuit. This gave excellent separation — the violin could be separated from the trombone, and the banjo from the saxophone.

In summary then, we have three horns in two separate groups, one horn in each group playing the piano, one horn in each group playing the banjo

(*Continued on page* 357)

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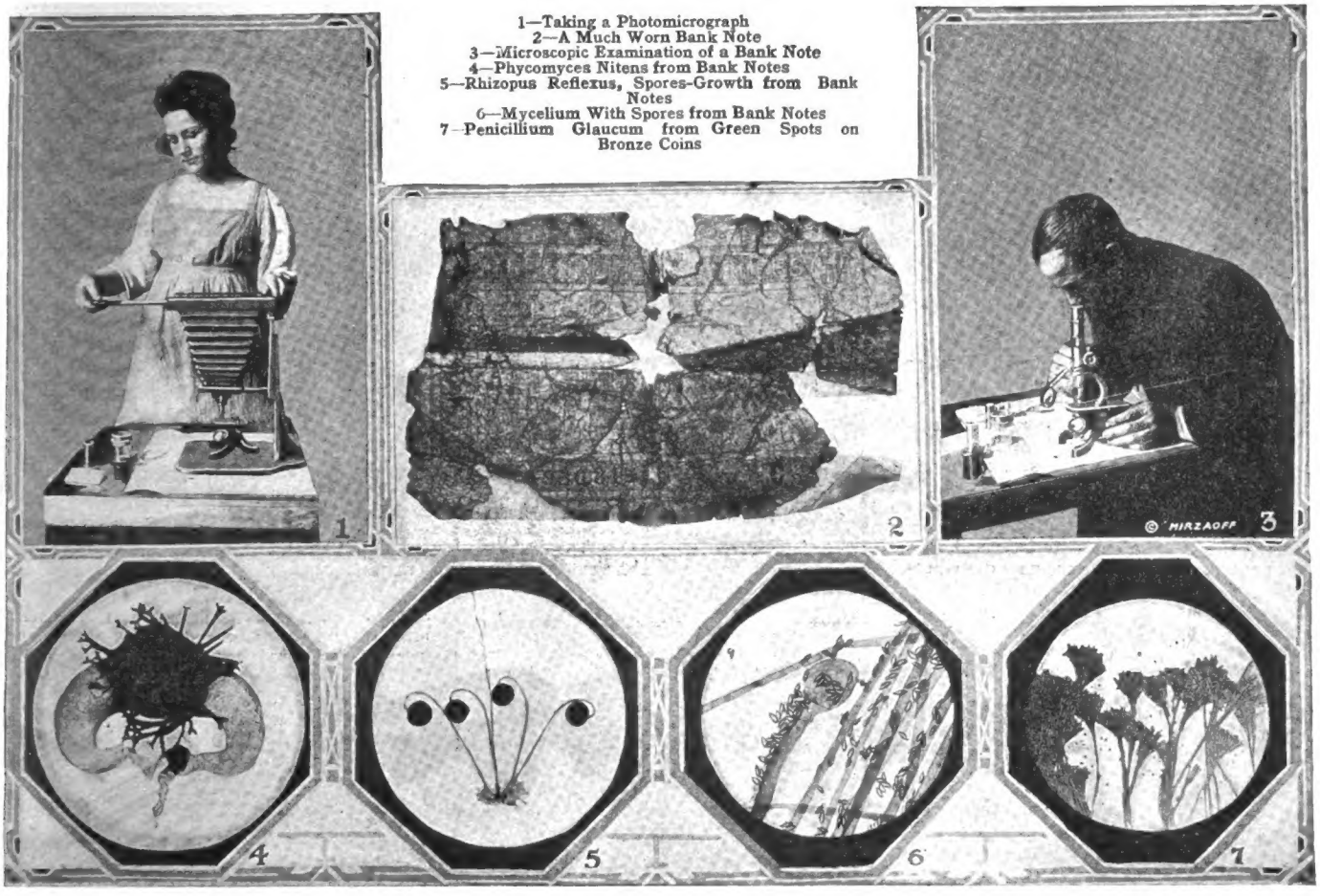
Disease Microbes Thrive on Money

MANY facts prove that certain disease germs are transmitted by books, bank-notes, gold, silver, bronze, and nickel coin. In the last days of his life, a consumptive emits volumes of germs and myriads of microbes, of Phycomicetes, of microscopic algae, and scores of other organisms accumulate on money in the course of its peregrinations, sometimes abiding in the pocket of a peasant and sometimes in presumably worse or in better environment. In France, just now, there is a tendency to complain of the repulsive condition of fractional currency.

1—Taking a Photomicrograph
2—A Much Worn Bank Note
3—Microscopic Examination of a Bank Note
4—Phycomyces Nitens from Bank Notes
5—Rhizopus Reflexus, Spores-Growth from Bank Notes
6—Mycelium With Spores from Bank Notes
7—Penicillium Glaucum from Green Spots on Bronze Coins



The microscope reveals a frightful quantity of bacteria, locked into the bundles of paper money, and like the Wandering Jew, paper currency travels all day long without rest, while the larger bank bills circulate much less intensively. The French mint is gradually replacing the paper fractional currency with coin.

More than thirty years have passed since a Hungarian botanist, Jules Schaarschmitt, proved the existence of an abundant cryptogamic vegetation (Schizomycetes, Saccharomycetes, algae, etc.) as well as other microbes, on the waste products of the starch maker, on cotton and linen thread, on hair, and on other organic debris. About the same time Professor Reinsch d'Erlangen found algae and bacteria on copper, gold and silver coins from all parts of Europe.

Examining a piece of paper currency with a magnifying glass some of the dust or roughness of its surface is scraped together with a needle and put into a drop of pure water, which has been placed on a microscope slide, and it is then examined with a reasonably high degree of magnification. There will be no trouble in identifying several varieties of Saccaromycetes (a ferment of beer, etc.) along with numbers of microscopic algae and bacteria (Micrococcus, various bacilli especially the putrefactive Bacterium Terma and the Leptothrix Buccalis, found in quantities on the human tongue, in the saliva and between the teeth). There are found more rarely, the spores of Mucor mucedo, of the lower species of mushroom, such as Phycomyces Nitens, and even the microscopic worm-like little vinegar eel, are often observed in organic debris such as cotton or linen thread, grains of starch, bits of hair, of skin, and the like. Microphotography applied to these subjects has many surprises for the botanist.

There is little difference between the respective flora of coins and paper money. Microscopic algae flourish better on the first than on the second, but the latter house many more colonies of microbes on their soiled and greasy surface, with its folds and wrinkles.

The germs on coins can be examined on exactly the same lines, as those we have described for paper money. In both cases a drop of distilled water on the slide, receives the collection from the coin, and in some cases quite high magnification may be necessary. Dr. William H. Parker has made a certain number of interesting observations in this line in the United States of America. He cultivated diphtheria bacilli on bank notes and coin, and found that they preserve their virulent power for several weeks. He then went on to examine money received daily in different mercantile establishments, and he found as many as thirty-six living diphtheretic bacilli on one-cent coins, forty on half dollars, twelve hundred and fifty on almost clean bank notes, and as many as seventy-five thousand on dirty bank notes.

Dr. Thomas Darlington, President of the Board of Health of New York, proposes to withdraw from circulation bank notes quickly infected, on account of the deplorable habit of our compatriots, of drawing them thru their hands, as they put them in their pocket. After a few months of use, these bundles of paper bank notes are as bad from the point of view of infection, as is the French fractional currency.

An American technician, Mr. F. B. Churchill, has invented a system of washing which will rejuvenate bank notes three times and he proposes to give the 5, 10, and 20 dollar notes this treatment, three times, before destroying them. He puts them into a globular vessel pierced with holes over all its surface, and this he immerses in a boiler in which a very hot soap solution is circulated at high speed. He washes out the soap solution in a second vessel, dries the paper money in a current of comprest air and rolls out the dried bank bills which have recovered their original crispness. Since then Mr. J. Ralph of the U. S. Treasury, has invented a machine still more perfect, for washing and disinfecting at one operation soiled bank notes. The notes are fed between two endless belts of fabric which carry them thru the cleaning and disinfecting solution and the rinsing water. In

(*Continued on page* 376)

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Photographing the Aurora

IN 1872 the Italian astronomer, Donati, formulated a theory of the nature of the aurora borealis. Nine years later, in 1881, a similar idea emanated from Dr. Goldstein. Both these scientists took the ground that the sun sends out into space streams of particles charged with electricity. These particles, they claimed, were the possible cause of electric and magnetic phenomena observed on the earth. Coming down to 1893 we find the Danish meteorologist, Adam Poulsen, putting forward the theory that the phenomenon of the northern lights is due to cathode rays. This view was based on his observation of the aurora borealis in Greenland, and he believed that these rays were formed in the upper strata of our atmosphere. In 1896 Professor Kristian Birkeland discovered, that a magnetic pole could concentrate cathode rays or similar electric rays to a small area, just as the rays of light are concentrated by a lens. This at once suggested that the earth, which is really a huge magnet with north and south poles, might in like manner concentrate electric rays from the sun. If it did this, the greatest concentration would naturally have to occur at the north and south poles.

It is in these regions that the aurora is observed, as either the northern lights or the southern lights.

The validity of this theory was tested by a physical experiment. Professor Birkeland suspended a sphere of iron in a vacuum bulb, and directed a stream of cathode rays towards it. Acting like the rays of the sun upon the earth or the moon, the cathode rays distributed themselves, as would a uniform light, over the nearer hemisphere. The sphere was next magnetized so as to develop north and south poles, and at once the rays assumed a characteristic and different aspect. The rays were now distributed in horn-like bundles of rays, whose points touched two ring shaped zones one around each of the poles, illuminating areas within these zones. This was the production by physical methods of the two auroras, borealis and australis.

Birkeland had already accumlated observation on the aurora borealis in 1899–1900, as the result of an expedition organized by himself. After the successful physical experiment, he formulated his first theory to the effect, that this phenomenon is the effect of secondary cathode rays, originating from vast systems of electric currents in the highest strata of the atmosphere, these systems of currents being formed by cathode rays from the sun.

This theory he amended later, when he came to believe that the aurora was directly caused by cathode rays from the sun. This theory was taken as a possibility in his treatise publisht in 1901, and was brought to a more or less definite conclusion in his book on "The Norwegian Aurora Borealis Expedition, 1902–1903." This book was finisht in 1913. Ten years earlier Dr. Carl Störmer, the eminent Norwegian mathematician, undertook to apply mathematics to the subject, and his first results appeared in 1904. He developed an explanation of the fact that auroras are generally confined to the Arctic and Antarctic Circles with a possible explanation of the arcs and curtains witnessed during auroral display. It was found that a beam of parallel cathode rays emanating from the sun, and descending into the atmosphere, was bound to become situated in a long narrow area, limited by magnetic lines of force and extending in the direction of magnetic east-west. Rays diffused over this area would then cause arcs or curtains.

Differential equations accumulated, and these had to be integrated. There were so many that to get numerical results proved to be an undertaking of no small magnitude. It required several years and the work was assisted by the Nansen Fund. It involved five thousand hours of work, and a number of the students in Cristiania University assisted in it.

Feature September Articles

The Paris Police Laboratory for Criminal Investigation—With wonderful photos. By Jacques Boyer.

Taking X-Rays at a Distance—Teleradiography. With X-Ray photos taken 730 feet from the bulb.

Opening Combination Safe Locks—Real secrets by an expert. By Jack Hartman, Safe Lock Expert.

A Sub-Atomic View Inside a Piece of Sugar—How the electrons make atoms, atoms molecules, and molecules the lump of sugar we sweeten our tea or coffee with. With a remarkable illustration.

The Transformation of Professor Schmitz—A crackerjack scientific story. By George R. Wells.

Insects and Worms That Eat Our Books. By William R. Reinicke.

Fortunes From Little Things—No. 3 "Animated Movies." By Charles Frederick Carter.

Can Human or Animal Tissue Live and Grow After Death?—With special illustrations. By William M. Butterfield.

A new $50.00 Prize Contest for Model Machine Builders—Full announcement in next issue.

The Amateur Magician. By Joseph H. Kraus.

New French Daylight Stereopticon—With photos.

A Radiophone and Continuous Wave Transmitter for Radio-Telegraphy. By Robert E. Lacault.

"Home Mechanics." By William M. Butterfield.

"Home Electrics." By G. L. Hoadley, M. E.

Animals That Live in a Drop of Water. By Dr. Ernest Bade.

With an extra good section of How-to-Make-It, Electrical and Mechanical devices. We are going to improve these departments right along. If you think of anything special you would like to see described, write us a few words about it, and we will try our level best to get one of our large staff of contributors and editors to prepare an article about the device or method in question.

The theory started with the assumption that electrically charged corpuscles emanate from the sun, approach the earth, and are influenced by its magnetism. The calculation had to be made how this emanation would have to take place so that the corpuscle should hit the earth.

The velocity of the corpuscle may be 10,000 or even 20,000 miles per second, and, in size, it is an inconceivably small particle, measuring perhaps one hundred-millionth of an inch in diameter. It can be imagined how great the labor was in calculating the trajectories of these little particles. Some were found to approach the earth and to glance off without hitting; others came fairly near, following a spiral path, and retreating on a continuation of the same spiral, without touching our globe. Other particles were calculated as revolving around the earth, far outside the orbit of the moon, and coming back toward earth—in airplane parlance, "looping the loop" vigorously, as they did so.

So far mathematics had not succeeded in finding a trajectory of a corpuscle which reached its target, the earth. Dr. Störmer then adopted another method and proceeded to calculate backwards from the earth to the sun, and at last found that he had caught the trajectories. More than 1200 working hours were occupied in calculating the path of these trajectories. Many of the trajectories followed a path surrounding the earth, curving inwards and on the night side opposite the sun, and this elucidates the fact, that the aurora borealis occurs at night. We publish a number of interesting photographs in illustrating Dr. Störmer's work. Indefatigable by nature he considers his work far from complete, and is now printing a large work on the subject. For the future he looks for a study of the spectrum of the aurora at various altitudes, to further elucidate its laws and origin.

By simultaneous photographs from different stations, the heights and situations of the lights are accurately calculated by the application of simple trigonometry. Sometimes they prove to be three hundred or four hundred miles above the earth, and at other times much lower. The cinematograph was applied and moving pictures obtained. Hundreds of successful photographs resulted. Where possible a star was included in the view obtained, and by this means a parallax for simultaneous observations at distant stations was obtained, by which the height was calculated. There were 24,000 such determinations of altitude; 53 or 54 miles was found to be the lowest limit of the northern lights. The greatest intensity occurred between 60 and 75 miles altitude and some were nearly 200 miles above the earth.

The system was adopted of telephoning from the main station near Christiania, Norway, to a number of secondary stations at various distances, so that during the years 1916 to 1921, 300 simultaneous photographs of auroras were obtained, in addition to a large number of single photographs of characteristic displays.

Numerous very excellent photographs of lightning flashes have been taken by amateurs. Of course, these are in a sense hit or miss exposures. The camera is pointed to the storm cloud, in hopes that the lightning flash will be obliging enough to cross the field of view. But when it comes to photographing the aurora it is another story. The illuminating quality of the aurora is distributed over an enormous space, so that it is much less intense per unit of area than the lightning stroke. Lightning storms are not infrequent, but in our latitude a fine auroral display is a great rarity. It is here that the Norwegian astronomers have a great advantage over us, as it is a simple matter for them to penetrate well within the range of frequent auroral displays. If we look at the map of Europe and realize that Madrid is at about the latitude of New York, we will get some idea of how far north Christiania, the metropolis of Norway, lies, and how readily a trip to the Arctic Circle can be taken therefrom. It is within the Arctic Circle that auroral displays are of daily occurrence in the winter months.

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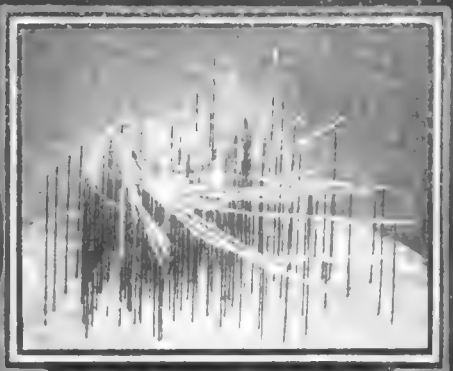
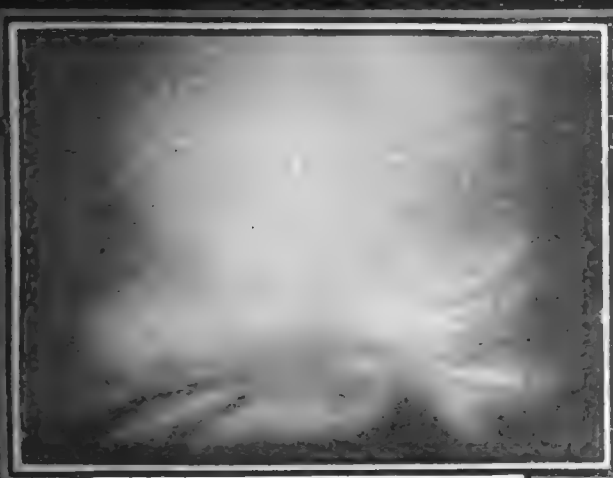
PHOTOS OF THE AURORA

Illumination of Magnetized Sphere by Cathode Rays.

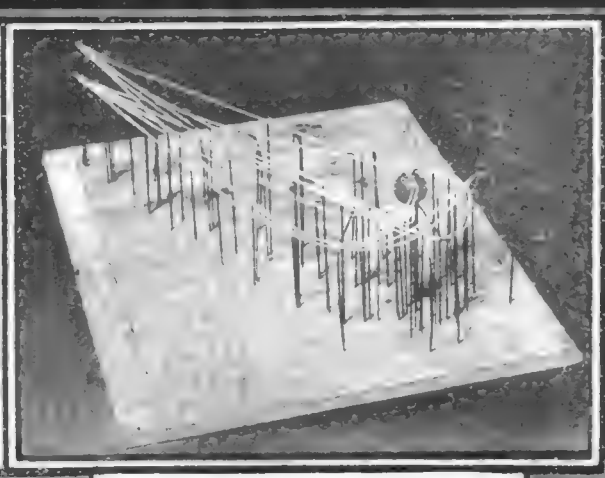
Auroral Arc Photographed.



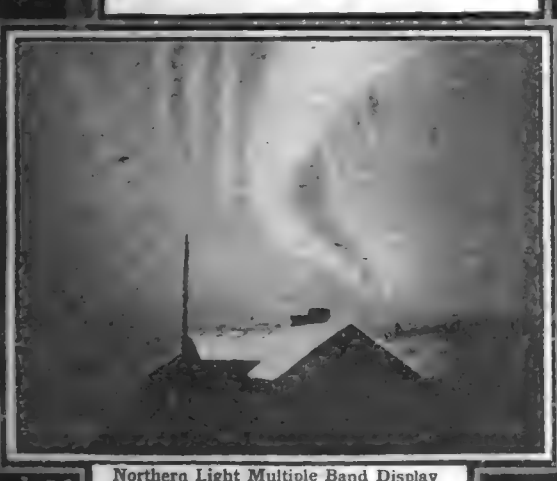
Trajectories of Corpuscles Approaching a Model Magnetic Sphere from Behind



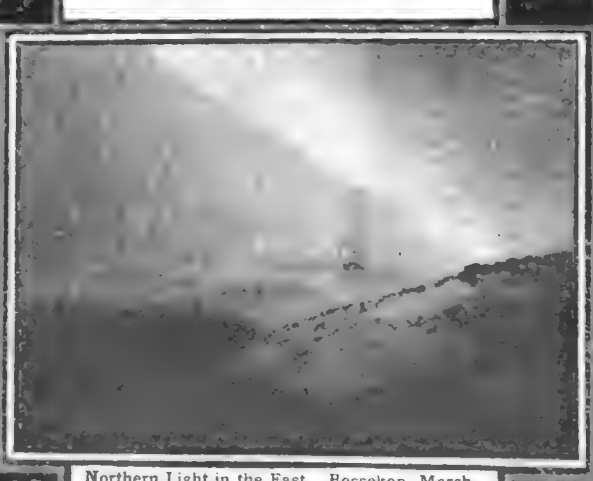
Auroral Corona Photographed at Night by Prof. Stormer.



Some Trajectories of Corpuscles Hitting the Auroral Zones of a Model of the Earth.



Northern Light Multiple Band Display from West to East Above the Zenith.



Northern Light in the East. Bossekop, March 3rd, 1910. Photo by Prof. Stormer

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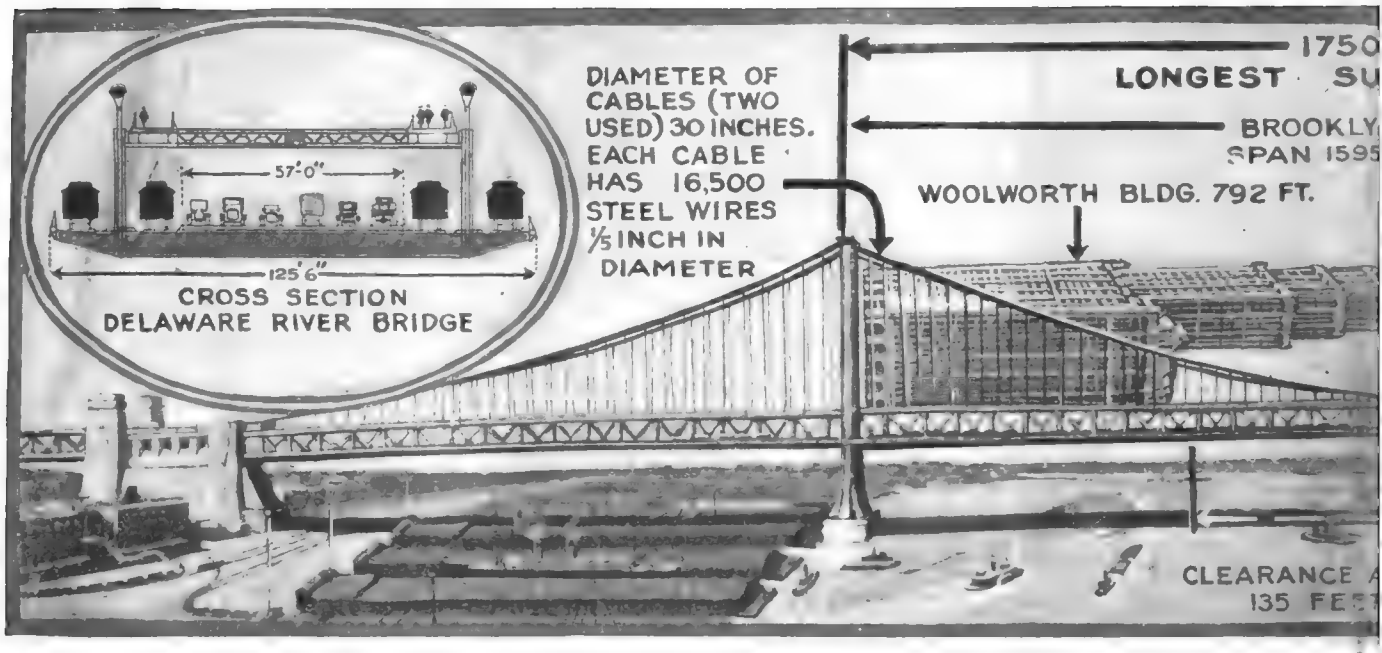

World's Longest Suspension Bridge

By DOUGLAS C. MINER

THE longest suspension bridge in the world will be constructed across the Delaware River connecting the cities of Philadelphia, Pa., and Camden, N. J. After several years of discussion, legislation and preparation, work is about to start. Five years will be needed to build this bridge. A two-cable suspension bridge with a 1750-foot span, and clearance of 135 feet, to cost $28,871,000, has been recommended by the engineers appointed by the Joint Commission of the two states and of the city of Philadelphia, which three places will divide the expense.

As an engineering feat the bridge will have no equal. Three of the nation's foremost construction engineers have laid the groundwork for this project: Ralph Modjeski, world's famous bridge builder of Chicago; George S. Webster, former Director of Wharves, Docks and Ferries, of Philadelphia; and Lawrence A. Ball. Paul B. Cret is the architect, and Leon S. Moisseiff, consulting designing engineer.

Summarized briefly, these are the main

Philadelphia and Camden to be Joined by Bridge Spanning Delaware River

facts or suggestions in the report of the engineers:

"That the structure cross the Delaware River with a single span 1,750 feet long center to center of main piers providing an unobstructed opening for navigation between pier-head lines.

"That the overhead clearance above mean high water be 135 feet over a width of 800 feet in the center of the span.

"That by reason of greater economy and greater ease and safety of erection and shorter time required for construction as compared with the cantilever type of bridge, the main structure be of a two-cable suspension type.

"That the bridge and approaches be built to provide a single deck carrying an unobstructed roadway for six lines of vehicles, also two lines for surface cars and two lines for rapid transit, and that two ten-foot sidewalks be provided above the roadway.

"That the foundation caissons of the main piers be sunk to bed rock, which is within practicable depth at the recommended locations."

The estimated cost of the bridge and approaches, including land damages, is to be divided as follows: State of Pennsylvania, $8,221,000; State of New Jersey, $12,429,000; City of Philadelphia, $8,221,000.

Since the organized cooperation between the two states set the machinery in action last autumn for first actual work on bridge plans, only one disturbing factor has entered into the situation. That has been the choice of site. The fight over site, of course, has its purely local angles, and devolved into a dispute between business interests in various sections of the city. The engineers in their report, submitted on June 10, recom-

An Amphibious Boat

We illustrate a cargo boat designed for use on the Congo River in Belgian Africa. It is the invention of M. Robert B. Goldschmidt, a Belgian millionaire engineer. The Congo River has many shoal places and when the boat comes to these, it is transferred to a mono-rail and travels rapidly along, still actuated by its own engine. This does away with the annoying portages incident to travel on the great African artery. In the Congo Region the river is everything, as the absence of railroads makes water transit the best of all modes of conducting traffic in that land of endless forests and few roads. The motors are to be fed with palm oil, a fuel which in Africa costs very little, and has a high calorific value. The boat will have power enough to pull two or three other boats of the same size, so that it can take quite a tonnage up the river into the heart of the Dark Country. It is interesting to think that the country can supply vegetable oil for fuel for internal combustion engines. One of the last ideas of Arctic explorers is to call upon the open ocean for their fuel and to drive their motor with whale oil. The photograph was taken upon a Belgian Canal on the occasion of its first trial trip.

A Boat for Use on the Congo River to Be Propelled by Palm Oil for Fuel and to Surmount the Shallow Places on a Mono-Rail Road.

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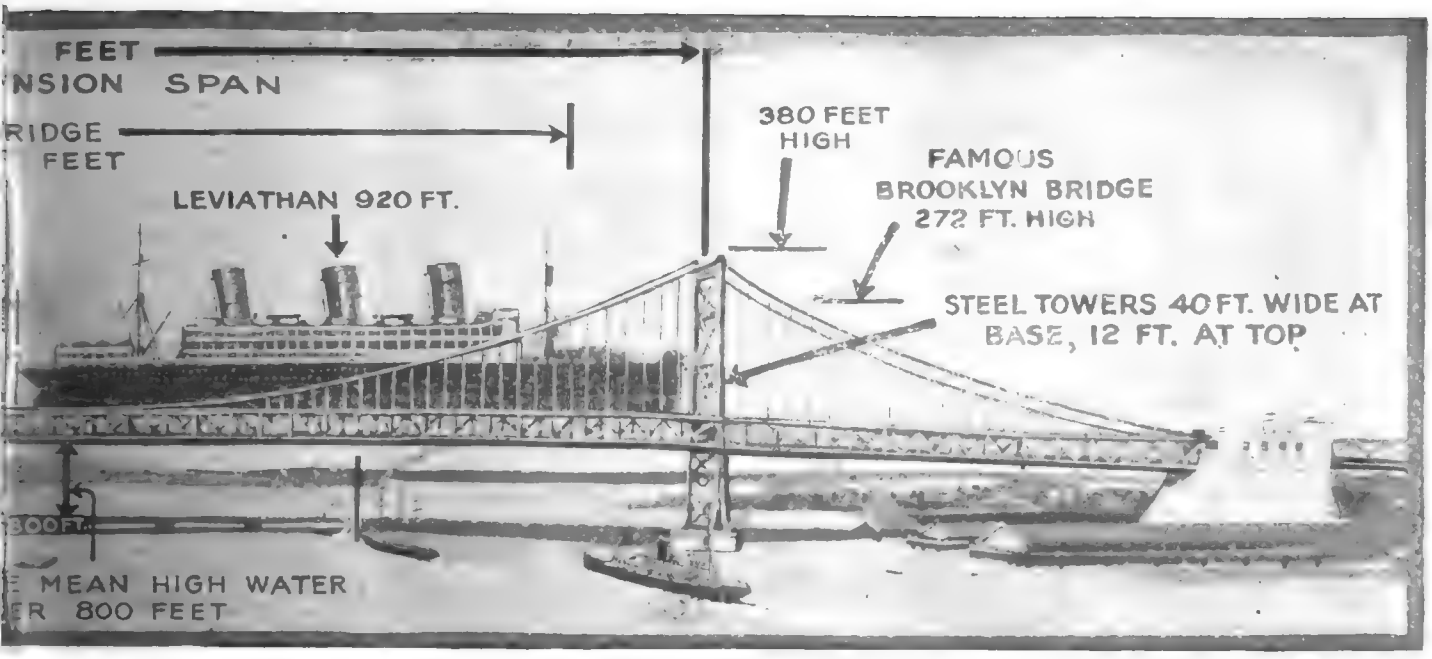

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Work Is Soon to Be Started on the World's Longest Suspension Bridge Which Will Span the Delaware River Between Philadelphia and Camden. The Central Span of This Bridge Will Measure 1750 Feet in Length and the Largest Vessels Can Easily Pass Under It. This Gigantic Bridge, Altho a Great Deal Larger Than the Famous Brooklyn Bridge and Capable of Carrying Much More Traffic, Can Be Completed, so the Engineers' Report States, by July, 1926, or in About Five Years' Time. The "Woolworth Building" and the Ocean Steamship "Leviathan" Could Rest Comfortably on This Bridge Between the Two Towers, With Room to Spare.

mended without bias and considering only practicability and economy, a bridge which should start at Sixth Street, between Race and Vine Streets, eight blocks from the water front in the city of Philadelphia, and cross the river in a straight line to Second and Pearl Streets, Camden, then curve southward to a point on Penn Street midway between Sixth and Seventh Streets.

The earliest record of a project to bridge the Delaware River connecting Philadelphia and Camden dates back to 1818. Organized effort on the present proposed structure began in 1914, and in 1919 a Joint Commission with full power and authority to proceed with construction was appointed, and on September 24, 1920, the present board of engineers was engaged to prepare a report.

Test borings were made and the distance below mean high water at which the first core-samples of rock could be recovered on the proposed site was found to be 86.7 feet on the Philadelphia side and 91.6 feet on the Camden side.

A detailed study of traffic conditions showed that the average daily total of passengers both ways during 1920 was 130,740, with nearly 200,000 on the maximum day. A bridge shuttle service is recommended for passenger transportation, with easy transfer to surface car routes. Additional tracks for rapid transit cars have also been planned.

In planning the actual design of the bridge a careful study of the four large New York City bridges between Manhattan and Brooklyn was made, and as a result it was considered best by the engineers that not less than six lines of vehicular travel should be provided for, the width from curb to curb on the main structure being fixed at 57 feet. Two ten-foot walk ways are provided for pedestrians. No roadway grades will be in excess of 3½ per cent, the trolley track grades being kept near a maximum 5 per cent grade.

All exposed masonry construction will be in granite, with backing or cores of concrete. Reinforced concrete is utilized for the roadway slab, with wood paving blocks because of their light weight. With no chance of a draft underneath, these could not burn, and the entire structure will be entirely fireproof.

The engineers decided in view of past experience that the suspension bridge involves less risk in construction, and can be manufactured and erected more quickly. A total of 33,000 tons of metal will be required, whereas a cantilever bridge would use 47,000 tons.

The versed sine, or vertical distance between the highest point of the cable curve at the towers and its lowest point at mid span will be 200 feet.

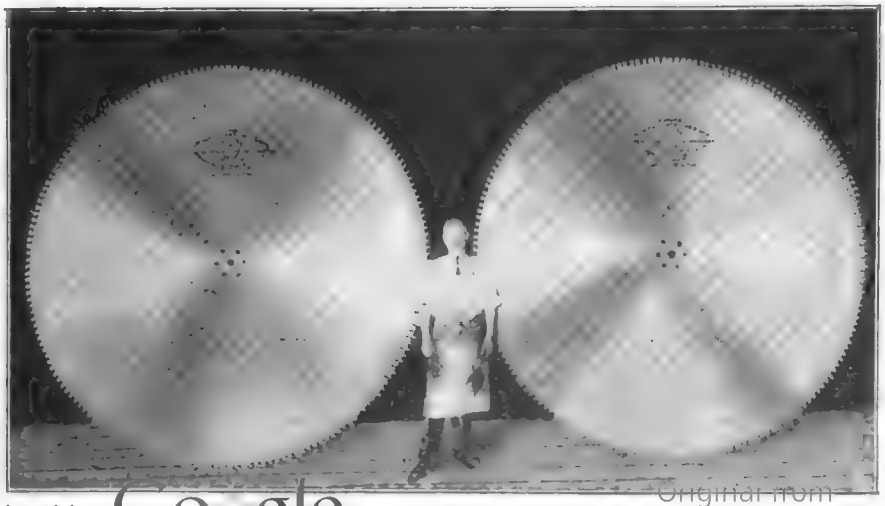
The East River bridge in New York has cables 20½ inches in diameter, but the choice of a two cable design for this new project requires a notable increase in cable diameter to 30 inches. Each cable will contain 16,500 wires of No. 6 size (.192 or about 1/5 inch in diameter).

The towers will be of steel, rising about 380 feet above water level and will be 40 feet wide at the base and 12 feet at the top.

Then came the question of approaches. Cutting into two cities where great condemnation of property would be necessary no matter what site should be selected, the engineers have carefully picked their way, and it is on this feature as much as any other that they recommend the Franklin Square-Pearl Street site. Roadways on both approaches will be widened to 63 feet. A plaza occupying two city blocks is planned on the Pennsylvania side, thru which run four roadways radiating from the central open space at the bridge end. West of this plaza is Franklin Square, a city park, providing plenty of open space.

The Largest Saws in the World

Henry Disston and Sons have a world-wide fame for their saws and a visit to the factory, for the privileged few who are admitted within its precincts, is most interesting. In spite of modern machinery and the last improvements, there is a great amount of handwork involved in producing perfect saws. As turned out from the machines there are always hard spots and strains which have to be coped with by the most skillful hammering with a peculiar hammer, the saw resting on an anvil. The huge circular saws



Two Huge Circular Saws Nine Feet in Diameter to be Used in Cutting up the Great Trees of the Pacific Coast

we illustrate, are 108 inches in diameter. They are to go to the Pacific Coast to be used on the great trees of the coastal forest. There are 190 teeth inserted in in the rim. It is the most impressive sight to see lumber handled in the Tacoma Mills, and the work of such saws as these is well worth seeing.

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Do Compound Eyes Magnify?

By WILLIAM M. BUTTERFIELD

THE reader can probably answer the question here proposed, in the most satisfactory manner by closing one eye and observing a landscape or object in this half-capacity fashion, for his visual machinery is similar to the compound eye of insects, because the reader's two eyes act in a stereoscopic manner to produce a single visual impression. If his eyes are normal he finds by the experiment that the impression is but slightly impaired by the closure of one eye, while with both eyes open he has augmented his stereoscopic vision, rather than increased his capacity to see. If he next examines the structure of compound eyes in any fully developed insect, he finds them spherical members which form a large part of the insect's head, composed of a large number of separate eyes, combined in such a manner as to form a system in which a centrally located optic nerve receives a *composite* sensation incited by thousands of eyes instead of two.

In the drawing, the top of the head of a bee with most of the eye lashes, or hairs, removed from between the hexagonal-shaped eyes, is seen, greatly enlarged. Some eyes are removed to illustrate the cone structure. It will be seen that the combination forms the greater portion of the head, terminated by a shell, in which four thousand eyes radiate in all directions.

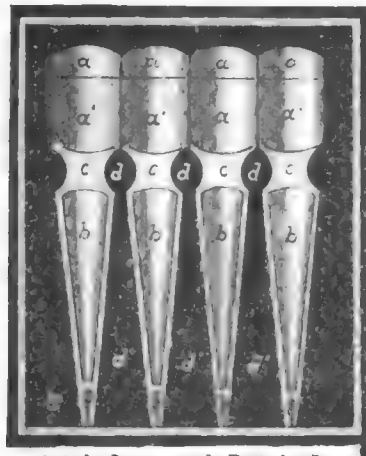
Each eye is provided with an anterior and a posterior lens, that *reduces* the picture of objects passing thru them to a size small enough to fall on the bulbous extremity of the optic fibers (e) located at the small end of each cone (b), from which the sensation is transferred to the trunk of the optic nerve (i) by means of its radiating fibers (g). The pupillary arrangement, which regulates the amount of light necessary for clear vision, is back instead of in front of the lenses as in the human eye (c), and a black pigment, fills the spaces (d′, d′) between the pupillary apertures and the cones.

Clear vision is obtained by adjustment of the pair of lenses, bringing them closer or farther apart, differing from the human eye, which changes the faces of the lens; by a regulation of the pupillary aperture; and by a reception of sensation on the bulb of the optic fibers and the usual transmission to the receptor centre in the brain. Whether this arrangement is multiplied by two as with our eyes, or by twenty-five thousand as with the Modella Beetle, the oneness of visual sensation would seem at first to be about the same.

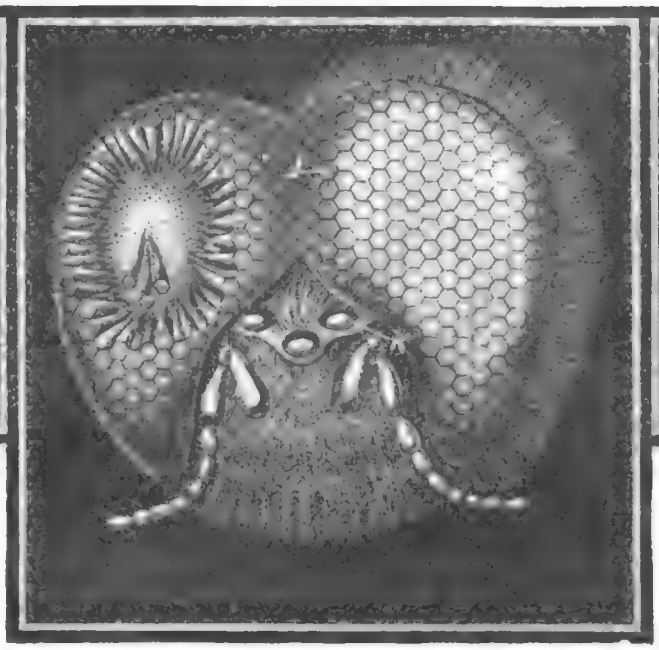
It has been said, often with a taint of derision, that there is a useless multiplication of organs in insects and crustaceans. But is this true? Surely not in compound eyes, for they have a globular exterior, often approaching a complete sphere, probably subject to the same aberrations that distort the reflection of objects falling from different angles upon any transparent globular surface. It will be found in looking thru a spherical lens from any angle, or from the center of a hemisphere, that there is but one place (its focus), where we can see an object clearly; and that all other objects which are reflected or transmitted are only seen as we move our eye to another point bringing those objects in the line of vision. The position and arrangement of the cones and fibers prove that this is true in globular eyes, filled as they are with aqueous humor and therefore optically solid. Every focus must therefore be provided with its eye and group of corresponding nerve fibers to overcome spherical aberration. In other words every possible angle at which the reflection of objects can fall upon the rounded outer surfaces of the combination must be provided with a separate eye.

Compound eyes have long been popular as microscopic objects, but to use them in this manner one must first take away all of the black pigment; the cones, nerve fibers and optic nerves, leaving nothing but the outer shell with its collection of so-called eyes. This shell when mounted on a slide and filled with Canada balsam—thus making it a solid segment or sphere—will reflect an object such as a small printed letter or figure, very clearly in each one of its hundreds of eyes. This phenomena has resulted in establishing many peculiar notions in regard to the multiplied vision of insects or of crustaceans, particularly as the eyes have

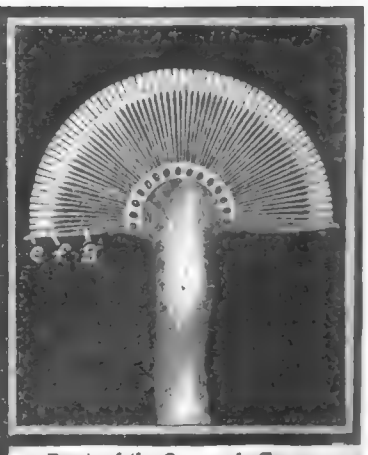
(*Continued on page* 35[5])



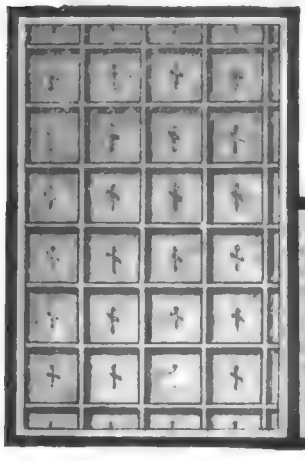
a—Anterior Lenses; a′—Posterior Lenses; b—Pyramids; c—Pupillary Apertures; d—d′ Pigment; e—Bulbous Extremities o Nerve-Fibers.



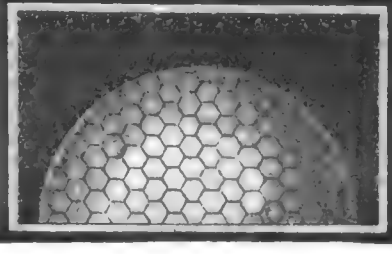
Ocelli In Two Eyes of Common Fly or Bee 4,000; Cabbage Butterfly 17,000; Dragon-Fly 24,000; Mordella Beetle 25,000: J—Ocelli. K—Cornet Eyes.



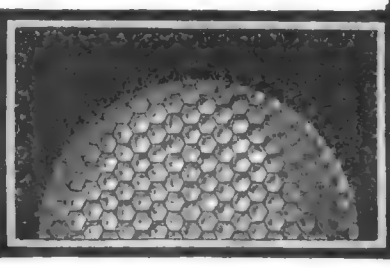
e—Facets of the Cornea; f—Transparent Pyramids; g—Fibers of the Optic Nerve; i Trunk of the Optic Nerve. Cockchafer or May Bug.



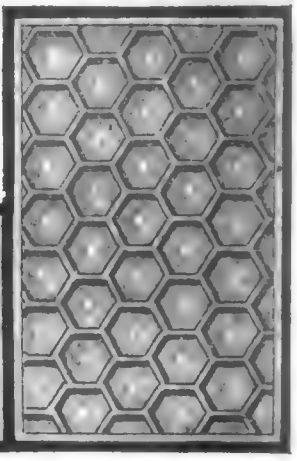
Greatly Enlarged Section of A Lobster's Eye.



Eye of Bee Reflecting Object in Lens of Each Ocelli.



Faceted Lens Made to Represent Bee's Eye.



Greatly Enlarged Section of an Insect's Eye.

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The Red Vote

By HAROLD F. RICHARDS

WE were just ready to go out to see Manarda kill his twentieth bull when the phone rang, and I heard Elon tell the clerk to send the visitor up.

"Jiordano, of Uruguay," he announced, as he hung up the receiver.

I knew my business and immediately opened the little file that we always carried in our luggage

"Here he is," I said, as I found his card. "A shifty politician, defeated for the presidency in 1904 by Victor Desuchez. Later appointed Minister of Internal Affairs as conciliation measure. Nationalists in full control ever since. Married Carlina Camboles, divorced wife of French manufacturing chemist."

"We'll soon find out more about him," said Elon, quietly, as he opened the door.

"Ah, Professor Hopkins, I have come clear from Montevideo to find you. Your science can save ten thousand lives in Uruguay!"

Jiordano was plainly agitated, and punctuated his dramatic ejaculation with a nervous flourish of his white-gloved hand. He made a dignified figure in his long evening coat and silk hat, and his black eyes darted keenly from Elon to myself as he talked.

"Yes?" interrogated Elon, motioning Jiordano to a chair.

"Cambadiera's party has won the election by an overwhelming majority!"

"Elections have been won and lost before, my dear Jiordano," interpolated Elon.

"But it is a trick, a foul outrage! The last three elections we have polled one hundred and sixty thousand votes and the Cambadieras a paltry ten thousand. Now the votes are counted and *we* have the ten thousand and *they* the hundred and sixty thousand. Montevideo is in an uproar. There will be revolution, bloodshed, God knows what! Oh, our peaceful country!"

"Come, come, Jiordano," Elon interrupted impatiently. "If the people have voted Cambadiera into office, why will they not stand for it?"

Our distinguished visitor immediately calmed himself and began more quietly:

"Ever since 1904, when our party came into power, the country has been in most peaceful condition. Business has flourished and there has not been a single revolution. We have won every election by a landslide, until in 1916 we polled over ninety per cent of all the votes cast. This fall the Cambadieras made hardly a pretence of campaigning. Everything was conceded us, even by their own press. But in the election two days ago the Cambadieras won by exactly the same majority that we had four years ago. In one district in which forty of our own campaigners voted we polled only twenty votes to four hundred for Cambadiera."

"Did your opponents spend much money?" asked Elon, who now seemed thoroly interested in the strange situation.

"Hardly anything at all. They never claimed ten thousand votes, and here they have won by a hundred and fifty thousand. Yet we can find no evidence of corruption. The Cambadieras had no workers at the polls and the whole election was in our hands. Now everybody crowds madly into the street, asking his neighbor for whom he voted, and everybody swears he voted for Desuchez. Nobody trusts anybody else, and at every corner there is fight and riot. They will not stand for his schemes. Cambadiera advocates government operation of the saloons, of lotteries and of houses of shame; he is opposed to public schools; he wants divorce granted upon request. N w that he has won, the worst element in the country has flocked to his banners. It will be impossible to live in Uruguay. But the people will rise. There will be revolution. We will be drenched in blood."

"And the ballots?" queried Elon.

"Safe in the State House, and nearly all of them plainly marked for Cambadiera."

"How soon can we get to Montevideo?"

Jiordano sprang delightedly to his feet.

"Ah, you will come. I knew it. In four hours we can be there. The Revenue Cutter that brought me is at the dock. And Professor Hopkins," he added, lowering his voice, "our campaign fund is scarcely touched. All is yours, if you will only solve this election."

Our grips were packed, for we had expected to take the morning steamer for Rio. In ten minutes we were comfortably seated in the small but luxurious cabin of the trim little ship, steaming rapidly down the broad Rio de la Plata. I half regretted the sudden departure, for I had set my heart

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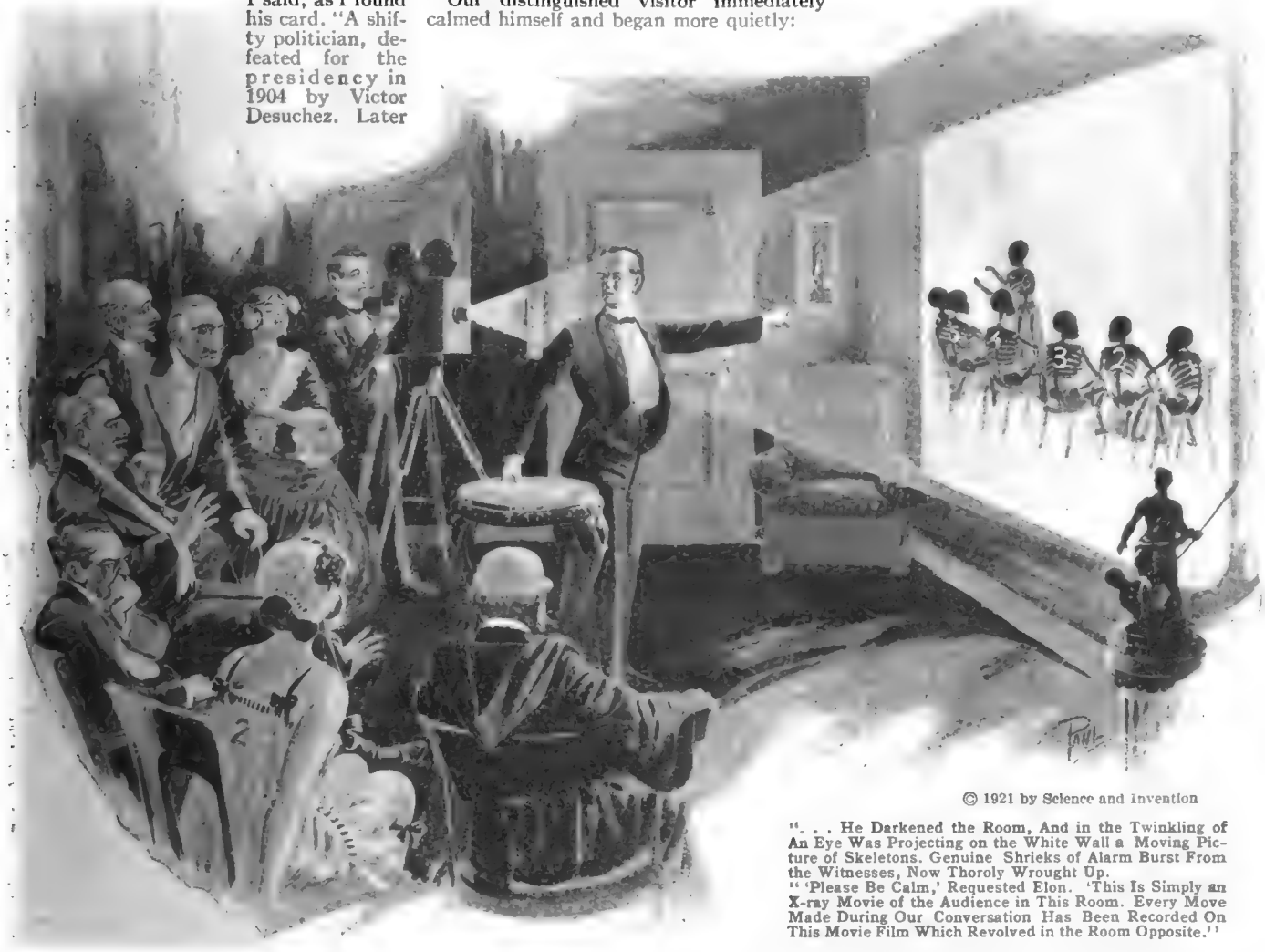

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". . . He Darkened the Room, And in the Twinkling of An Eye Was Projecting on the White Wall a Moving Picture of Skeletons. Genuine Shrieks of Alarm Burst From the Witnesses, Now Thoroly Wrought Up.
" 'Please Be Calm,' Requested Elon. 'This Is Simply an X-ray Movie of the Audience in This Room. Every Move Made During Our Conversation Has Been Recorded On This Movie Film Which Revolved in the Room Opposite.' "

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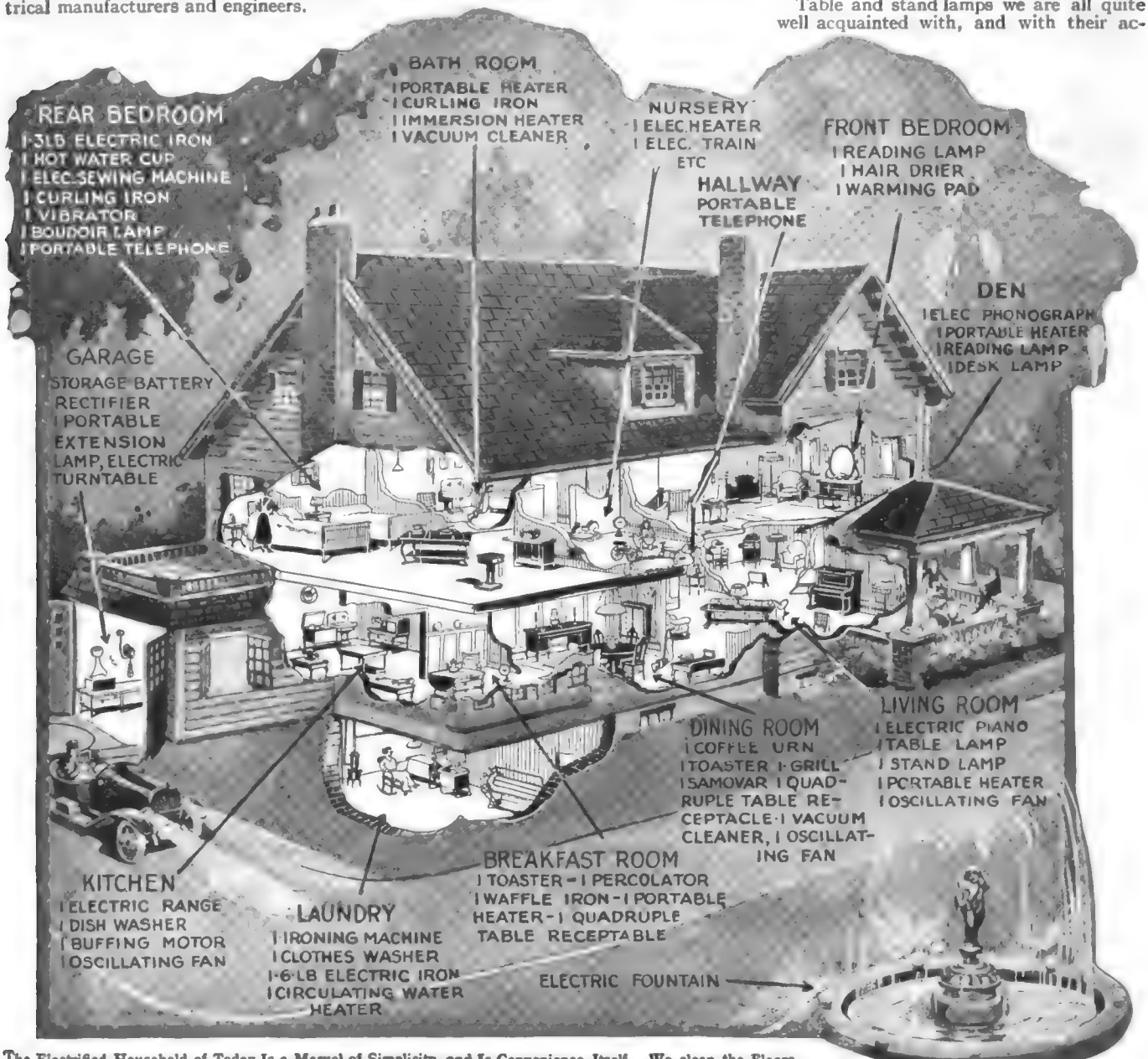
Electrical Home of Today

AMERICANS are rapidly coming to the front in their adaption of the many applications of electricity in their homes—more so we believe than is the case in any other country. One of the principal reasons for this rapid growth of the utilization of electricity to perform all sorts of chores about the household, from heating milady's curling iron, to playing the automatic electric piano, is due in great part to the ingenuity and progressiveness of American electrical manufacturers and engineers.

of course, at least when it comes to considering the average house and with regard to whether or not Mr. and Mrs. Householder intend having their new house wired with a great multiplicity of outlets—they say, some of the new houses in the highly electrified districts of California have as many as 150 to 200 outlets. It is a typical electrified house of this type which is shown in the accompanying illustration. In the districts where the K.W.H. rate is low and even special rates are in force for

electric dish washers and this is probably one of the most important devices, and one which the woman who does her own housework will surely be delighted with. The average Mrs. Householder will find several important jobs for electricity to perform, such as polishing the silverware by means of a motor and buffing wheel, and where the head of the house will O. K. it, the electric range has proven capable of producing the most delicious roasts and other delicacies, of the cuisine that one can imagine.

Table and stand lamps we are all quite well acquainted with, and with their ac-



The Electrified Household of Today Is a Marvel of Simplicity, and Is Convenience Itself. We clean the Floors Without Raising a Bit of Dust, and the Air Is Circulated and Cooled by Fans in the Summer Time, and Rejuvenated by the Ozonizer in the Winter. All the Grounds About the House Are Well Lighted by Electric Lights, and an Electric Fountain or Two; While Even the Servant Girl Would Rather Live in the Electrified House of Today Than She Would in an Old Style "Flat" of Her Own, as She Would Not Know What to Do Without the Wonderful Conveniences Supplied, Even for Her Own Use. Sanitation, Light, Good Air, and Health Go Hand in Hand in the Electrically Equipt Home of Mr. and Mrs. American.

In the western part of the United States, where electric power is a great deal more cheaply produced, thanks to the many large waterfalls and rivers which have been harnessed for the production of electrical energy for light and power, the kilowatt-hour rate is from ¼th to 1/10th what it is in the East. With such a lower K.W.H. rate, people feel more disposed of course to use such devices as electric stoves, hot water heaters, fans, etc., than they do where the rate is as high as 10 to 15c. per kilowatt-hour. The cost of electrical energy per kilowatt-hour is one of the important factors

electric heating and for night service, as well as for consumers, who use more than a certain minimum amount of energy, even the small homes have 75 to 100 outlets. And now they are making special electrically wired furniture, the wires passing up thru the hollow posts or pedestals of the furniture.

We are all more or less familiar with the common applications of electricity in our homes, but the lady of the house is particularly interested of course, in what the magic current can do for her in the kitchen. There are now available several very good

companying convenience, as well as the good graces of the reading lamp for a place beside the bed. The modern bedroom equipment usually includes an electric hair-dryer as well as a heating pad, curling iron, a massage vibrator, a small electric iron perhaps, and an electric sewing machine, if a separate sewing room is not available.

They have improved the dining room in the modern electrically lighted house and it is no longer considered *de rigeur* to have a lot of wires or cables dangling down from the dining room table, the wires leading

(*Continued on Page* 354)

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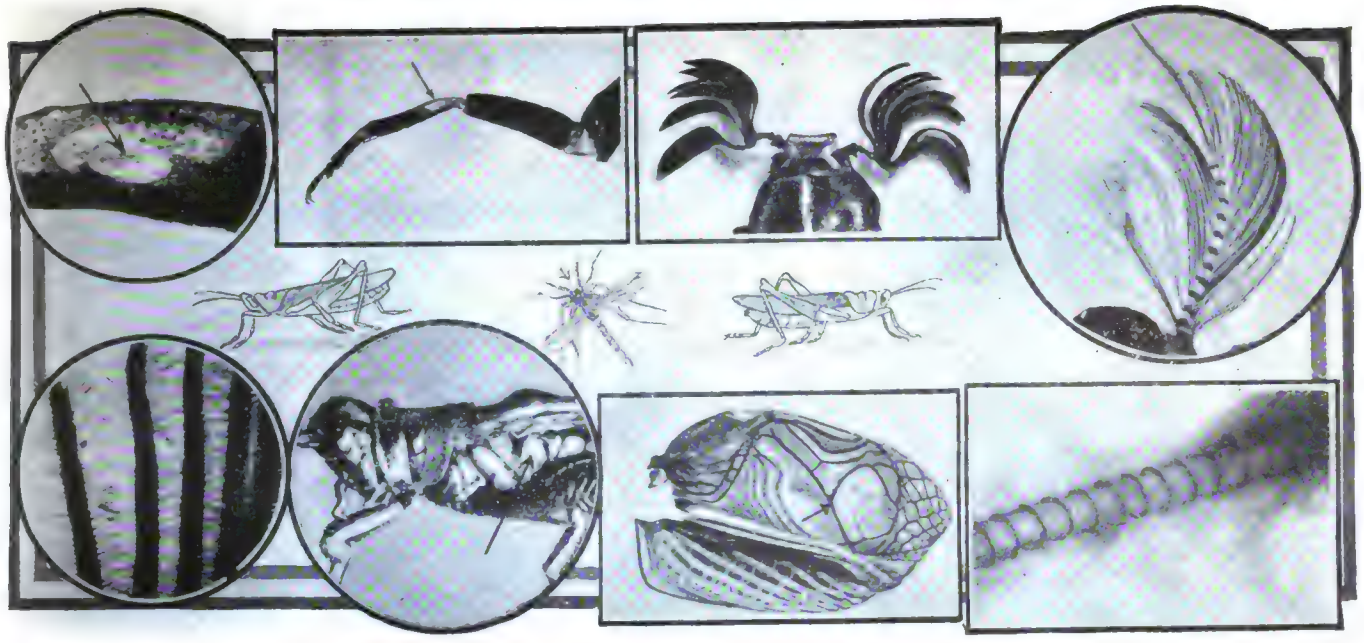

Top Row Left to Right—Arrow Indicates White Part or Ear of Cricket Which Is Found on the Two Front Legs Only; Front Leg of Cricket, Arrow Showing Position of Ear; Feelers of a Beetle; Feeler of Male Mosquito Enlarged Fifteen Times. Lower Row Left to Right—Branches and Hairs of a Moth's Feeler; Arrow Indicates Position of Ear on Grasshopper or Locust; Wing and Wing Cover of Cricket, Arrow Indicating Position of Thickened Vein Where Music Is Made; Part of Thickened Vein Magnified 150 Times, Note Staples.

How Insects Hear and Smell

By DR. ERNEST BADE

THE intense heat of the Indian-summer's midday sun burns down upon the meadow and the forest. Those places, which are covered with the golden rod, glow with a soft radiance. The stiff and grotesquely shaped sumachs begin to show the dark, velvety red seedpods.

"Shrip, shrip," is the call from the fields; "shrip, shrip," is the answer from the bordering forest. It is the male of the long-horned or green *grasshopper* sitting on the foliage of trees and shrubs, where the green body is admirably protected, so that they are seen with the greatest difficulty. Tirelessly the base of the left wingcover is rubbed over the base of the right wingcover, in this way producing the call of the male to the silent female. Here the wingcovers are especially constructed for the production of their characteristic noise. A thickened vein, which is covered with numerous tiny teeth, can be noticed on the left wingcover with a powerful hand magnifier. On the right cover a roundish, glassy spot is found, surrounded by thickened veins. The teeth are rubbed against these veins, and this causes the membrane between them to vibrate and give forth that whirring or shrilling sound we hear.

Other grasshoppers cause the thickened front vein of the wingcovers to vibrate, by rubbing their hind or jumping leg, which is covered with spines, over it. The crickets produce their music like the long-horned grasshoppers, the only difference being, that the thickened vein of their front wing is covered with minute U-shaped staples, in place of the more simple teeth or spines.

When the dusk begins to fall, the katydid can be heard on bush and tree. Only when the air is cool and a cold wind is blowing is its song somewhat uncertain. It seems as if the last syllable is frozen. The did can not be uttered. Even between the Kay and the di a perceptible pause is made. At other times the kay-di-did, kay-di-did, is fluent enough.

Another common sound-producing insect is the *harvest-fly*, whose song has long been under observation. Even the ancient Greeks have given it some thought. When placed upon a harp, it represented the expression of music.

The harvest-fly's organ of sound is situated on the underside of the abdomen, just beneath a pair of broad leathery plates, whose posterior end is free. It appears as an elastic, longitudinally folded membrane spread over a chitinous ring. With the aid of a powerful muscle this membrane can be loosened or firmly stretched at will; at the base of the leathery plates an air hole is found which amplifies the sound produced.

But all insects are not provided with music-producing organs, and in fact, very few of the millions of known species are able to make distinctive sounds. But where an insect makes a sound, another must be able to hear it. It has been proven that a great many of the male insects, which are able to make sounds, stimulate the female of that species. Therefore these must have ears.

In former years it was thought, that the ear must be situated on the head, the antennae functioning as such. Today it is known that the ears need not necessarily be situated there, for the grasshoppers and crickets have them in entirely different parts of the body. The green grasshoppers *have their ears on the front legs!* The same is true of the crickets. The grasshoppers, or locusts as they are sometimes called, have their ears on the side of their abdomen, on the first abdominal segment. Such tympanal membranes are definitely separated and marked, and are found on all insects which produce sounds. And this music can be likened to the lovesong of the male, thru which it attempts to make its advances under more favorable circumstances, or to cajole the female to him.

But, as has been said, the greater part of the insects are silent, like the ants, and these are not susceptible to sound vibrations, but are influenced by various odors. So the grave-digger beetle flies long distances to reach the place of a dead animal. Another beetle which feeds upon a certain fungus growing under the ground, bores a tunnel thru the ground to the desired morsel. Such pieces of food are always found with certainty, altho the fungus does not possess an odor perceptible by man.

It is very difficult to say anything general about the insect's sense of smell. As a rule the organs, for the perception of odors, are situated in the antennae or feelers, where the sense of taste is also often found. Sometimes the palpi are fitted with the organs of smell. These organs consist of rounded cylinders, slightly protruding, and more or less blunted, formed from chitin. At times they are found in slight cavities. A peculiar fact is, that the males are provided with a greater number of such organs than are the females. As the organs of taste are formed in a somewhat similar manner, it is sometimes difficult to distinguish between them, but if they are found within the mouth parts, they are undoubtedly organs of taste.

The more important and common insects, which are attracted thru odors, are the *butterflies*, and the *flies*. Fabre observed a female moth (Gastropacha quercus), a very rare nocturnal insect of his native country. The third day after the emergence of the moth from the pupa, 60 males were hovering about the window, altho the female was in a wire cage, and placed 12 to 15 feet from the window. Fabre was doubtful if the males were brought to the female by its scent, since the nose could not detect the slightest odor. When the female was placed in a tightly closed box, no males made their appearance. They only came when the female was exposed. Next it was attempted to destroy the scent of the moth thru naphthalene, carbon disulfid, petroleum, or tobacco smoke. The female was then placed under a bell-jar near the window, and a plate of sand upon which the moth had rested was taken and brought into the room. The males flew over the butterfly into the room, and alighted on the sand.

Therefore it is impossible to doubt that an odor must be given off by the female which calls the male of this species to her. Experiments with other female moths led to the same results. As we cannot detect even the slightest odor, which seems distinctly perceptible to the male, since they are often attracted for more than half a mile radius, some naturalists have come to the conclusion that the odor, which is given off, is not a sending out of tiny particles of a substance, but a wave motion of certain lengths and similar in character to those sent out by light and heat.

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Telephone Amplifier Hurls Sound 4 Miles

Recently Music was Transmitted Thru the Air for About Four Miles and a Spoken Voice Told Its Story About Three Miles From the Large Wooden Horns, Shown at the Left of the Illustration. The Original Voice Actuated an Ordinary Microphone, Such as We See on a Desk Telephone Set, and When This Current Was Received in the Laboratory, Shown at the Right. A Large Number of Vacuum Tube Amplifiers or Audions Boosted the Voice Ten Billion Times. The Receiving Station was Located at Naponach, N. Y.

LET the reader imagine himself on one of the most secluded slopes of the Catskills. The scene is that of a wooded landscape on a perfect summer's day, and the only sounds are those typical of a peaceful countryside at this season of the year.

Suddenly the entire region is filled with the sounds of music. It appears to come from no one direction but fills all the surrounding space. It is not particularly loud and yet each note and instrument is clear and easily distinguishable. Investigating the source of this surprising music, he finds no fairy orchestra hidden in the recesses of the hills. Instead, a guide who understands the mysterious occurrence, leads him down the hillside and across a valley, a distance of four miles, to a low steel tower, carrying at its top several large wooden horns or "sound projectors."

Yet where does the music really originate: The guide answers the question by saying that the origin of the music is a phonograph, one thousand miles away, in the City of Chicago; that this phonograph is placed before a telephone transmitter, and that the variable electric currents generated by it, are transmitted over the Bell Telephone System's long distance circuit, to an electrical amplifier placed at the foot of the tower in this little valley in the foothills of the Catskills.

All this was no imaginery occurrence. The tower and its accompanying amplifiers were recently erected for a special demonstration before the telephone officials of the Bell System by the engineers of the American Telephone and Telegraph Company. It was similar in most respects to the Bell loud speaking equipment used at the National conventions last year, and by President Harding in his inaugural address on March 4th, at which time his voice was carried with the greatest ease to a crowd of over 125,000 persons, the more remote of whom stood seven hundred feet from the speaker's stand. At the recent demonstration at the little village of Napanoch under the Catskills, the sound of a speaker's voice, who stood at the base of the tower and spoke toward a nearby transmitter, was also projected across the valley and proved perfectly intelligible more than three miles away. Music could be distinctly heard at four miles.

The projecting of the human voice over the enormous distance of three miles has been made possible only by exact and painstaking scientific development along three distinct lines. First there is required a telephone transmitter so perfect in its operation that it will reproduce with absolute fidelity the complicated waves of the human voice in the form of electric currents. In the second place, an amplifier is required, which will magnify with perfect accuracy the minute and varying currents transmitted over the long circuit from Chicago. Finally, there are attached to the sound projectors, large telephone receivers of such skillful design, that they re-convert the magnified electric currents into sound waves without the slightest distortion.

The transmitter used in this demonstration does not depend in its action upon the microphonic property of carbon granules, but consists of two metal plates clamped rigidly in an insulating frame, the latter so accurately constructed, that the layer of air separating the plates is but one one-thousandth of an inch thick. These two metal plates form the plates of a simple electric condenser, whose capacity is determined by the thickness of the air film between. As sound waves strike one of the plates, the resultant vibration of the plate varies the thickness of the film of air, thus changing the capacity of the

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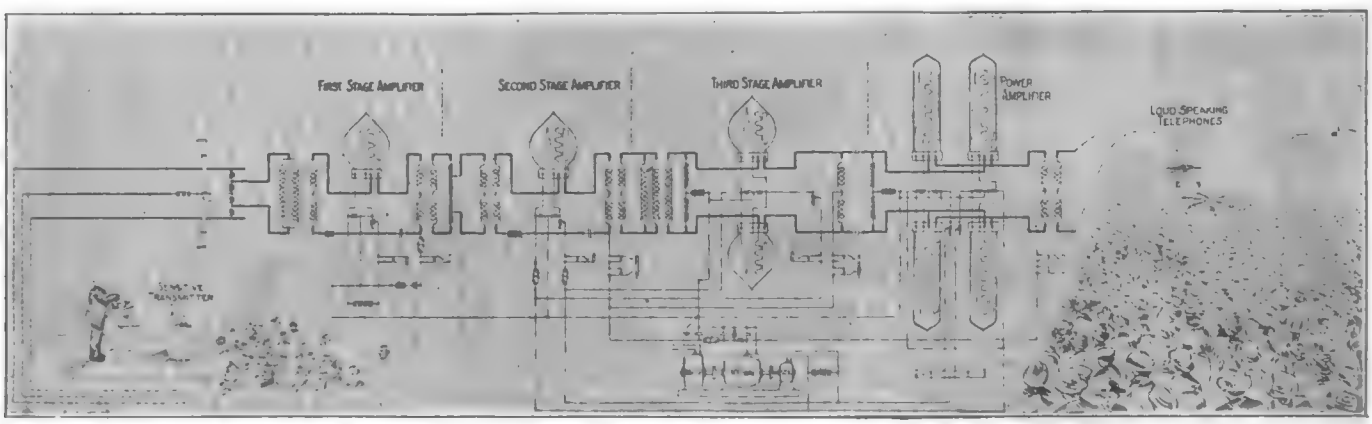

The Circuits Employed in the Telephonic Loud-Speaker, Illustrated Above, are Here Shown, Including the Vacuum Tube Amplifier Circuits, as Well as Those for the Power Tube Amplifiers.

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Inventions That Have Earned Wealth

By CHARLES FREDERICK CARTER

Story of the Fountain Pen

AFTER trying carpentering, school teaching, and a position as instructor in the University of Virginia, Lewis Edson Waterman took to soliciting life insurance in 1880 when he was 43 years old. Learning by sad experience, as many another man has done, that prospects often change their minds, while hunting for a pen to sign an application for a policy, Waterman armed himself with a fountain pen one day, when he hoped to sign up a candidate for a big policy.

This Is the Story of the Fountain Pen as First Conceived and Developed by Mr. Lewis Edson Waterman, Whose Likeness Appears in the Center Photo Herewith. The Story of the Fountain Pen as Perfected by Mr. Waterman, Is One of the Most Interesting That Mr. Carter Has Yet Given Us. Unlike Many of the Leading Fountain Pens Now on the Market, the Pen Retaining Mr. Waterman's Name Is One of the Simplest Imaginable, as Becomes Readily Apparent by Inspection of the Sectional Drawing and Detail of the Feed at the Right of the Illustration. The First Year's Output of Fountain Pens, All Made in the Rear of a Cigar Store in New York City, Was but 200 Pens, While Today It Would Require a Good Sized Ocean Steamship to Carry One Year's Output of the Waterman Fountain Pen Alone, Not to Mention the Scores of Others on the Market.

At that time more than two hundred patents for fountain pens had been issued and many varieties of such pens were on the market. They were good average pens, too. That is to say sometimes they wouldn't give down any ink at all; at other times they would give down by the gallon; but the average was all right.

As Waterman's victim touched that fountain pen to the dotted line, it let out a great blot of ink in a sudden access of generosity, flooding the paper so that it had to be thrown away. While Waterman hurried back to his office to make out a new form, a rival came along and signed up the prospect.

This so embittered Waterman that he abandoned the life insurance business and turned his attention to the development of a fountain pen, that would write. After three years of tireless experiments, that always ended in disappointment, he hit upon the right idea. His first patent was granted in 1884.

The difficulties which other near-inventors had found insurmountable had been the insufficiency and irregularity of the feed, and the inability to control flooding, or blotting.

Waterman's feeding device is made out of a single piece of hard rubber containing on one side a plain square groove in the bottom of which are slits or fissures 3/64 of an inch wide and 1/16 of an inch deep. This small feed piece being inserted into the open end of the ink reservoir, the ink flows down the fissures, while air passes up into the reservoir through another slot, so that every drop of ink may be used. This arrangement, with tiny cups in the "spoon," or feed piece beneath the pen, automatically regulates the feed and effectively prevents flooding.

Waterman's first establishment was in the rear of a cigar store on Fulton Street in New York City. The first year's output of 200 pens was made by hand. Then he did what every business man who hopes to succeed must do: he advertised his Ideal Fountain Pens. That first advertising campaign wasn't much to speak of, for Waterman's capital was extremely limited, but it brought in so many orders, that he was obliged to increase his facilities.

Development of the fountain pen business, thus begun, has never ceased. Early in 1921 a new factory, the sixth now in constant operation, with a floor area aggregating 250,000 square feet, was opened in Jersey City, N. J. Two other factories are in New York City, two in Seymour, Conn., and one in Montreal, Canada.

Here's the Fountain Pen De Luxe—Solid Gold Shell With Inset Diamonds—Price? Ah, Yes—$250.

Fountain pens cannot be stamped out by the million by automatic machines, as is possible for bottle caps or cheap alarm clocks, but must be carefully made by highly skilled workmen. Measurements must be accurate within the thousandth part of an inch. In some steps the supersensitive fingers of the workman gages the work by the "feel." No fewer than 210 distinct operations are required to turn out a completed fountain pen. Just to give an idea of the extent of the gold pen manufacturing part of the business, the sweepings from the floor of the room in which the pens are ground are sold for $4,500 a month, while more than $500 worth of gold is reclaimed monthly from the water in which the grinders wash their hands and faces. Every grinder is supplied with a new pair of overalls each month, the old ones being burned, in order that the gold in them may be reclaimed from the ashes. Each pair yields about $5 worth.

Today there are more than twelve hundred employees on the Waterman payrolls, three hundred of them being in the executive offices, which, with the retail store at the corner of Dey Street and Broadway, occupy an entire building. Branch service stores are located in Boston, Chicago, San Francisco, Montreal, eleven cities of Europe and several cities of South America, for the cornerstone of the Waterman business is service to the user. No matter where they may wander, the users of fountain pens will find a repair depot within easy access by mail. Literally thousands of retailers thruout the world carry an assortment of fountain pens. Rival pens come and go, but no formidable competition has ever developed. Waterman died twenty years ago but his son, nephews, and grand-nephews are carrying on.

Some fountain pens carried in stock retail for $250 each. Of course one may buy a cheaper pen if one is willing to renounce diamond insets. But who would want to use a commonplace pen, costing as little as $2.50, when one could have a gorgeous gold affair like the pens carried by Lloyd George, Elizabeth, Queen of the Belgians, and the Prince of Wales? Special pens are made to order costing very much more than the diamond studded stock styles. Speaking of styles, there are no fewer than 540 distinct stock numbers, each of which may have ten different grades of pen points; so that the vaults contain about 5,400 stock drawers, to meet the varying requirements of the writers of the world.

The fountain pen has been developed into a world-wide institution by extensive and continuous advertising. The first little quarter page ad. in the Century Magazine has been increased, until now upwards of $200,000 is spent annually to swell the demand for Ideal fountain pens.

More than twenty millions of Waterman's fountain pens are in use thruout the world and the number is being increased at the rate of more than ten millions a year. Even the Japanese, altho their own language is written in ideographs with a brush like Chinese, have taken a great fancy to fountain pens, for they are obliged to employ English as the language of commerce and diplomacy.

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"Black Lightning"

By FERDINAND ELLERMAN

OF THE THE MOUNT WILSON SOLAR OBSERVATORY, PASADENA, CALIF.

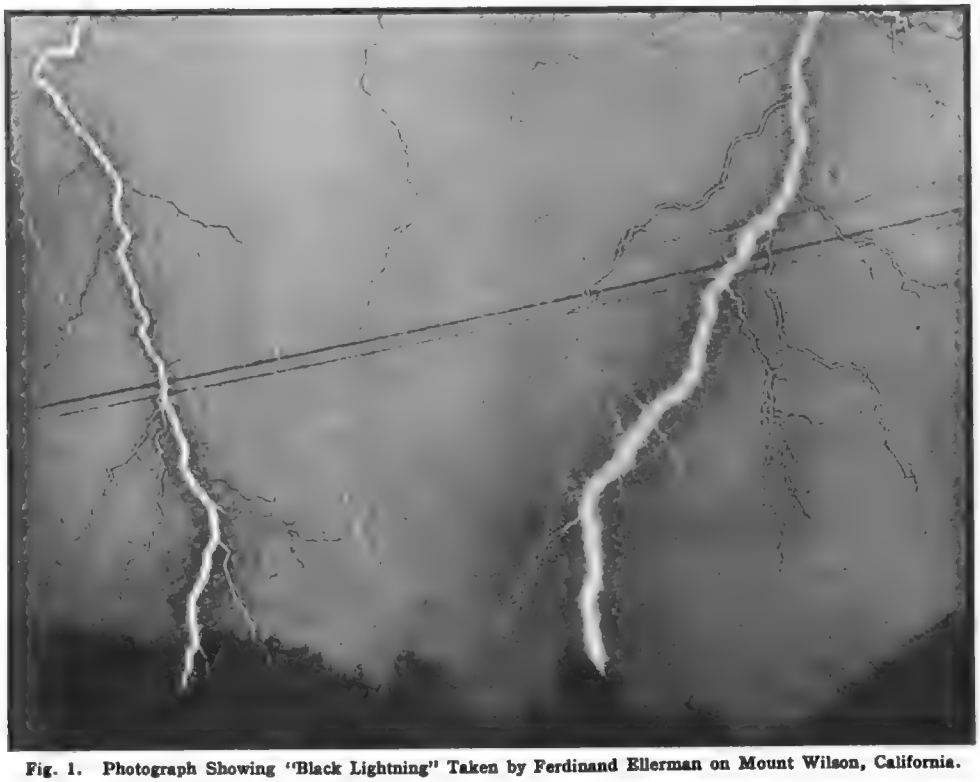

Fig. 1. Photograph Showing "Black Lightning" Taken by Ferdinand Ellerman on Mount Wilson, California.

THE phenomenon known as *black lightning* is one that is reproduced occasionally on plates or films that are exposed for recording images of the lightning flashes, and always excites curiosity. The phenomenon has always been of interest to me, altho I had not secured any exposures which exhibited it, until the night of June 30-July 1, 1918, at which time Southern California was visited with a most violent series of lightning storms, beginning about 10 o'clock in the evening and lasting till 5 A.M.

The storm was the culmination of several days of sultry weather, and past along slowly from SE to NW. Very little rain fell, and very little wind accompanied it. There would be localized centers of activity, and from Mr. Wilson, where these plates were taken, six distinct centers of disturbances, covering an area of about 1000 square miles, were visible at one time.

Lightning storms are not common in this locality, and I was therefore not prepared for the wonderful display of aerial fire-works that it was my good fortune to witness. I did, however, get a camera ready, and exposed a number of plates, in order to get some good lightning flashes.

When these plates were developed next day, a curious result was evident. The plates exposed during the earlier part of the night did not show any reversals or *black lightning*, but as the night progrest, the plates showed more and more, till at 4:30 A.M., when plate C165 (Fig. 2) was made, all of the flashes show black lightning.

The saying that "Curiosity once killed a cat" had no terrors for me, after witnessing this storm. I therefore began a search for literature on the subject to explain this reversal, which, while photographic, was not the ordinary reversal due to over-exposure and it is admirably illustrated in Fig. 1, where the tips or ends of the branches of the lightning are reversed, the edges dark and the strongest flashes bright with dark edges.

During the search I came across an article on *photographic reversals* by Professor R.W. Wood of Johns Hopkins University (Astrophysical Journal 17, 1903, p. 361) in which he describes the *Clayden effect*, a phenomenon of a certain kind of photographic reversal, and the following is quoted from that article.

"The *Clayden effect*, which is the type chiefly to be dealt with in the present paper, occurs when an exposure of about 1-1000 of a second or less is given, and the plate fogged subsequently by exposure to diffuse light before development. If images of electric sparks are thrown on a plate, and the plate is then exposed to the light of a candle for a few seconds, the sparks will develop reversed, which is not the case if the exposure to candle light precedes the impression of the spark images. . . As I showed several years ago, the Clayden effect, or the type of reversal giving rise to the phenomenon of *dark lightning*, results from the action of a light-shock on the plate, before its exposure to diffuse light."

The Clayden effect, as explained above, would solve the mystery of black lightning, if only the first flash or image reversed, and all the subsequent ones were bright. Here would be the simple reversal of the first flash by the illumination of the background from subsequent flashes, causing the background to develop strong, and leaving the places clear where the first lightning images were. But the explanation of such combinations of reversals as Figs. 1 and 2 show is not satisfactorily given, especially in Fig. 2, where every main flash shows reversal, and of equal intensity, and yet it was these very flashes that illuminated the background, and there was at least one minute time interval between flashes so that the last one must have been impressed on a slightly fogged background, and yet there is strong reversal.

"Dark Lightning" Experiments in the Laboratory.

The Clayden effect as produced in

Fig. 2. Another Remarkable Photograph Showing "Black Lightning," Which Was Taken by Ferdinand Ellerman on Mount Wilson, California.

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the laboratory is beautifully shown in Fig. 3. Here we have two spheres about seven inches in diameter, separated by an air gap of about three inches. A difference of potential of about 220,000 volts fails to break down the dielectric, until a vulcanite (hard rubber) rod is brought close to the top of one of the spheres, when ionization begins and carries the current along the lines of force in a curved path to the top of the other sphere. A number of sparks follow the same general direction, then the dielectric breaks down between the spheres and when the arc is formed giving the high flare, the background is illuminated. When a plate has been exposed to an image of this, we find that the images of the first sparks are reversed, more or less completely, according to the strength of the spark-image or fogging light. Had the plate been covered before the arc formed all the spark images would have been bright as is shown by other negatives accompanying the one from which Fig. 3 was made. I am indebted for this illustration, to Professor Harris J. Ryan of Leland Stanford Jr. University, who kindly sent me negatives and permitted me to use them for illustration.

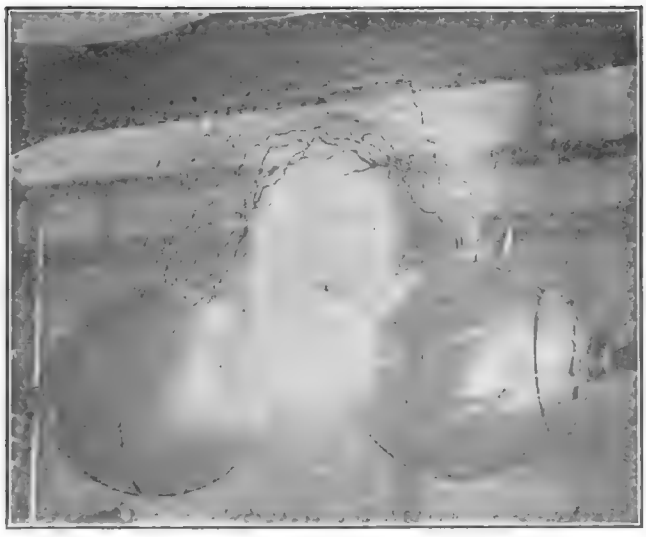

Fig. 3. "Dark Lightning" As Produced in the Laboratory. The Discharge Took Place at a Potential of 220,000 Volts Between Two Seven-Inch Metal Spheres.

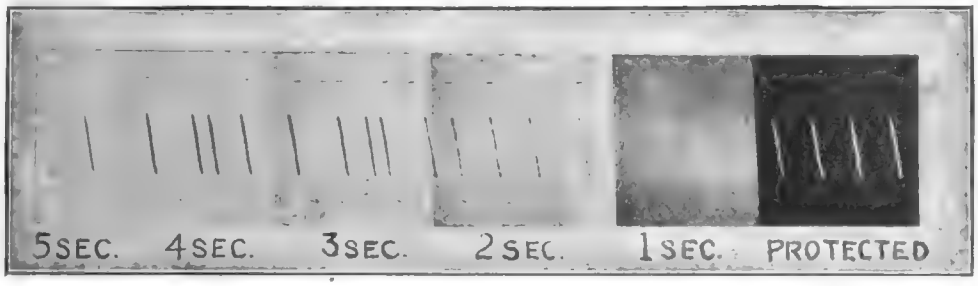

Fig. 4. Images of Electric Sparks Reversed by Fogging the Plate After Exposure, for 1, 2, 3, 4 and 5 Seconds, to a Weak Light, Illustrating the Clayden Effect. The Bright Images on the Dark Background Are the Parts of the Plate Which Were Protected.

In making experiments on the Clayden effect, it is found that the greater the difference in actual time of the light shock, and of the fogging exposure, the easier the reversal is produced. The weaker the light shock, the weaker the fogging exposure necessary, and conversely, the stronger the light shock, the stronger is the fogging exposure necessary, until a limit is reached, perhaps when images, such as those of lightning, are so strong, as in Fig 1, that the light action has gone too far to be capable of reversal by subsequent fogging.

If a series of spark images are imprest on a plate, and half the plate is fogged by one spark, and the other half is exposed to a candle or lamp sufficiently to fog it, then, on development, the half fogged by the one spark will show nothing but fog, while the other half will show the spark images as positives, illustrating the fact that the fogging must be of a soaking kind. If the plate is held farther away from the spark, and the fogging is done by exposure to 8 or 10 sparks, a weak reversal is obtained. The duration of the first exposure must be very short, preferably 1–10,000 second or less, altho reversal can be obtained with exposures as long as 1–1000 second, as Professor Wood has shown in his article referred to.

To anyone wishing to make experiments in the line of *dark lightning*, I would offer the following suggestions:

Have at least three cameras, not necessarily large, with lenses of good quality having aperture of F/8. Films are more convenient than plates for rapid changes. Change the film in one camera after every flash; in the second after two or three flashes, and in the third camera let quite a number of flashes impress themselves. In that way, it seems to me, much could be learned about this subject.

As the summer is before us I hope that readers of this article will take up the matter as suggested above, and I shall be pleased if I can be of assistance to anyone undertaking the work.

The Smallest Thing Extant

By GEORGE A. BEANE, Jr.

A GRAIN of sand lay on the floor, a tiny thing indeed;
So very small a particle, the eye could scarcely heed.
This mite of stone by vanity was carried quite away,
And said, "I am the smallest thing existing here today."

"Well, well," spoke up another voice from somewhere down below,
"Your views I have to contradict, you do not seem to know
That I am smaller still than you. I and my friends within
That little heart of yours reside, so we the title win."

The mite of sand was sorrowful, this woeful news to hear,
So greatly it affected him, he shed a stony tear.
And then began the tiny grain, "I never heard of you;
And furthermore I can't believe the things you say are true."

"That's easy!" said the stranger voice. "You did not know of me.
Because I am so very small my form no one can see.
So now perhaps you'll understand just why I ought to rule.
My name? Oh, yes, I most forgot, 'tis Bobby *Molecule*."

The disappointed grain of sand had just begun to weep,
When lo! another stranger voice came calling from the deep,
And to the Molecule it said in tones of lofty scorn,
"You are of great and ponderous size and from *my* kind are born."

The Molecule, who up to now, had thought himself so small,
Began to quake for fear that he would lose his place withal.
"If you are smaller still," said he, "then kindly give your name,
For I will not give up my place just to advance your fame."

"Then listen," said the tiny voice, "and you will understand
Just how we are the smallest things in Lilliputian Land.
Alone we have no value, but 'tis our reunions form
All combinations that exist, subject to nature's norm.

"Upon a needle's tiny point, you may believe or not,
A hundred thousand of my kind could do the latest trot.
They call me indivisible; the very smallest thing,
They christened me the *Atom* and I'm going to rule as king."

The Molecule was just about to render up the crown,
When from Infinity there rose a whisper soft as down.
"Your arguments have been in vain," it said in accents gay,
"I claim the right to rule as king of all small things today.

"I am a million times at least a smaller thing than you,
Your movements I control and guide, in everything you do.
I am pure Electricity, I stand in mankind's grace.
Primordial in Nature I pervade the cosmic space.

"My name it is *Electron*, and I am the most minute
Of anything that's known to man, and this you'll not dispute."
The Atom quite reluctantly—hard smitten with his loss—
Knelt down and past the longed-for crown unto his new-found boss.

And as the tiny group of four went whirling on thru space,
I wondered if some smaller thing would take Electron's place.

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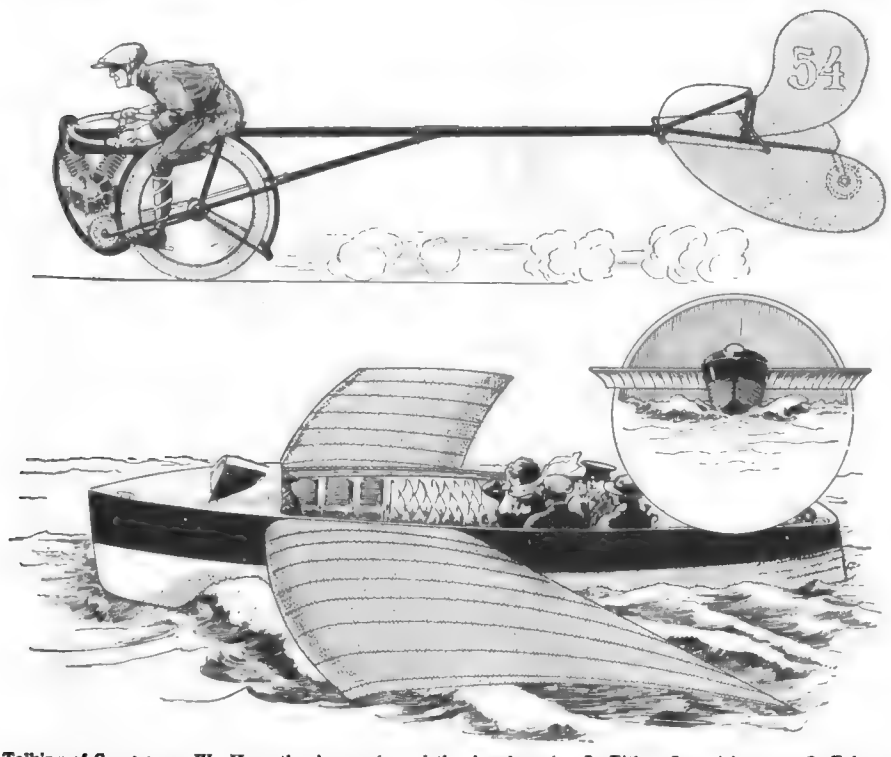
The Aerocycle

NOW anyone can ride a "one wheel bicycle" and a one wheel motor cycle; a new kind of vehicle which is a combination of a motorcycle and an airplane now makes this possible. It is called an "aerocycle."



Talking of Sport Here We Have the Aerocycle and the Aerolaunch. In Either Case Advantage Is Taken of the Lifting Effect Created by the Wind Surfaces Which Also Manifests a Distinct Stabilizing Characteristic. The Aerocycle Has But One Wheel, the Horizontal Planes and Vertical Aerial Rudder, Serving to Balance the Vehicle When It Reaches a Certain Speed. The Launch Will Tend to Be Lifted Further Out of the Water, as the Speed Increases and Thus Reduce the Resistance Encountered in Driving the Hull Thru the Water

Having asked the inventor of the aerocycle if he had constructed it from odds and ends, he replied, "Many say it is an odd looking 'bus,' but I have used no 'odds' in making it, but for the 'ends' I must say it is made of the ends of a motorcycle and an airplane!"

As will be seen in the picture, a fairly long extension is rigidly secured to the back of a motorcycle, being braced by a length of tubing which is forked and fastened to the axis of the wheel. At the end of this extension is an elevating plane, a vertical rudder, and a starting and landing wheel. The engine and the extension nearly balance, the extension being a little heavier. The elevating plane is *immovable*, i.e., it is secured rigidly to the extension. It is absolutely automatic in its action. It is interesting to note how automatically it works. You will understand this, when you consider what takes place while starting and stopping. During the slower speeds at which the vehicle travels when first starting, the starting wheel is on the ground and the elevating plane is inclined at its greatest angle. This great angle causes the extension to be easily lifted while the vehicle is traveling at a comparatively slow speed. As the speed is increased, extension lifts still more, the angle is decreased and the elevating plane assumes an approximately horizontal position, until the entire vehicle is in its natural "high speed" position, at which time the elevating plane stops rising and furnishes only enough lifting power to hold the entire vehicle in this position.

Therefore it will be seen that this automatic elevating plane accomplishes two important functions; firstly, it causes the starting and landing wheel to stay off the ground most of the time, i.e., it is only on the ground when the aerocycle is run at a comparatively slow speed; secondly, it prevents the vehicle from being tipt over towards the front. This is exactly what is desired and it is accomplisht by simply having the elevating plane rigidly attached to the extension.

The steering arrangement is very simple and is similar to that found on airplanes. A cross bar is attached to the pivoted bar which supports the vertical rudder. A wire from each end of this cross bar leads to the ends of the handle bars. The wires pass thru several eyes.

The aerocycle offers a new sport for "speed kings." It is the fastest "land" vehicle known.

This vehicle can, of course, also be built for foot power and can be propelled like a bicycle.

The Fonolier, A Light For The Phonograph

In the accompanying photograph is shown the latest electric battery light, particularly designed for use on the phonograph. The phonograph light is making its need more manifest each day, particularly where the talking machine is in a dark corner of the parlor or other room. Often records have been scratched by taking a chance in trying to change needles or in lowering the reproducer on the moving record, when the surface of the record could not be clearly seen.

The Fonolier, as it is called, comprises a lamp and a neatly made battery measuring 4 x 3 x 1¼" for supplying current. When the battery becomes exhausted, the contact screw, forming the switch at the back of the clamp fitting over the top of the battery is loosened, and the lamp unscrewed from the socket built into the battery, the lamp attachment is then screwed to the new battery.

On the average, a battery will last from one to three months, depending upon how often it is used. The lamp is fitted with a nickel reflector and the whole device is very neat and unobtrusive, the battery being neatly covered with black bookcover paper. The lamp is lighted by turning the switch screw to the right; turning it to the left extinguishes the light.

There have been several battery type phonograph lights brought out from time to time, but some genius undoubtedly will shortly perfect a simple and reasonably priced electric light for the phonograph which can be operated on 110 volt lighting circuit, by simply connecting the light by means of a flexible cord and attachment plug to a base receptacle or the chandelier. It is really quite a peculiar thing when one stops to think about it, that so little apparently has been done in the inventive field and with the modern phonograph so far as electricity is concerned. There should certainly be room for a vast lot of improvement in talking machines, thru the combination of electricity and mechanics. True, we have electric motor-driven phonographs, but even these are few and far between, the winding of the motor still being done manually to a very large extent. There seems to have been quite a little trouble encountered in perfecting a satisfactory motor-drive for phonographs, which would cause the machine to rotate at a sufficiently constant speed, and the second problem has been the elimination of noise.

In the Accompanying Illustration, One of the Latest Battery Type Phonograph Lights Is Shown in Operation. Whenever the Talking Machine Happens to Be in a Dark Corner, and There Is Danger of Scratching the Records, These Little Lights Perform a Valuable Service, and the Editors Have Used One of Them with Great Satisfaction Perhaps Some Genius Will Wire the Phonograph Cabinet of To-morrow So That a Light Is Also Supplied for Examining the Record Titles in the Lower Part of the Cabinet

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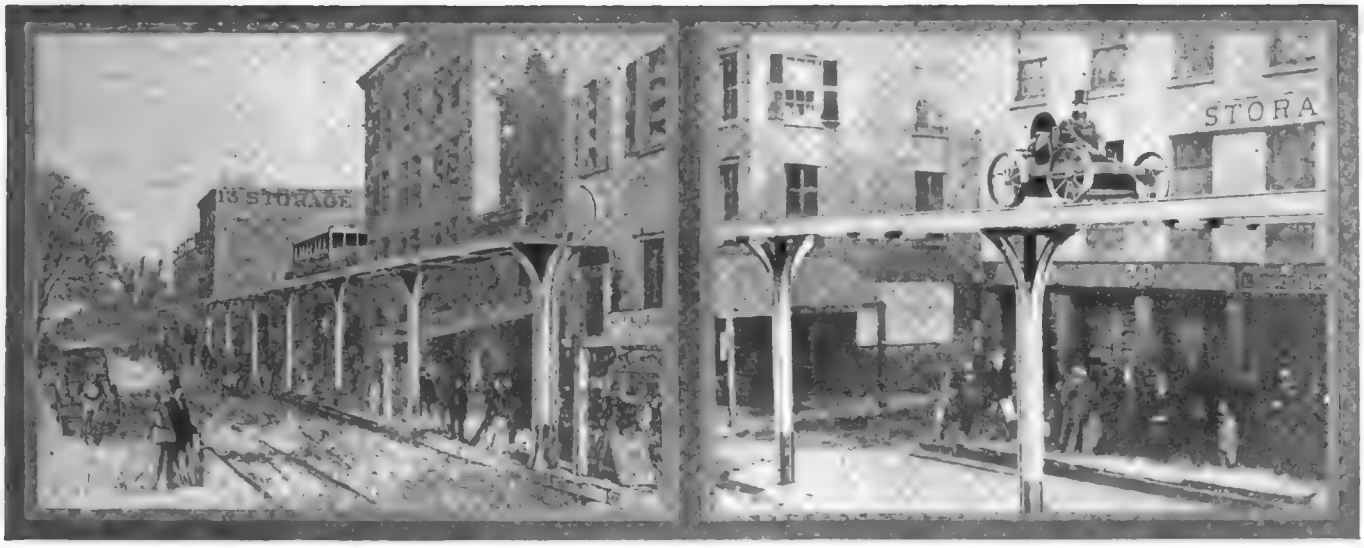
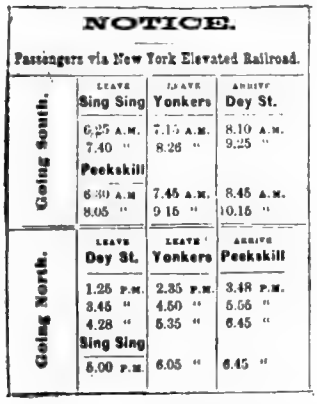
The First Elevated Railroad in New York



The New York and Yonkers Railroad in the '60's, One View Reproduced from "Harper's Weekly" of 1868, Showing a Passenger Car in Lower Greenwich St.; the Other Shows the Inventor in a Handcar, from an Old Photograph in the Possession of the New York Historical Society.

IN the late '60s of the last century, the proposal was made to build an elevated railroad from lower New York City up to Yonkers; and we illustrate from old records the first elevated railroad in lower Greenwich St., New York City. It has not yet reached Yonkers. These pictures go back to 1868. The idea then was to produce a very simple structure, carried by a single row of steel columns, on which cars were to be driven by cable.

One idea was to have the driving lay of the cable between the rails, while the return was to be underground, the hollow columns presumably offering a tempting suggestion for carrying the cables down to the level of Mother Earth. This idea was, however, abandoned in favor of having both lays of the cable practically on the track level. One of the views shows the end of the road near the Battery and Greenwich St., New York City, with the ends of the rail bent up to prevent the cars from running off. This cut is from *Harper's Weekly* of 1868. From an old photograph in the possession of the New York Historical Society, we reproduce a view of the railroad with the inventor or the deviser of it riding thereon in a handcar; in both these views not the least interesting part is the aspect of the city before the days of steel frame structure, of knee-length skirts and other modern improvements.

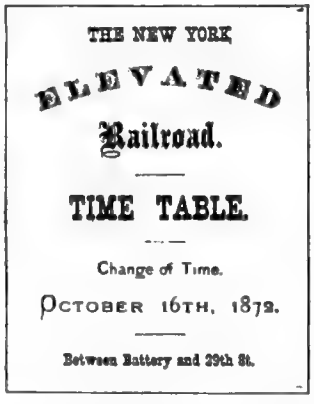


NOTICE.

Passengers via New York Elevated Railroad.

	Leave Sing Sing	Leave Yonkers	Arrive Dey St.
Going South.	6.25 A.M.	7.15 A.M.	8.10 A.M.
	7.40 "	8.26 "	9.25 "
	Peekskill		
	6.30 A.M.	7.45 A.M.	8.45 A.M.
	8.05 "	9.15 "	10.15 "
	Leave Dey St.	Leave Yonkers	Arrive Peekskill
Going North.	1.25 P.M.	2.35 P.M.	3.48 P.M.
	3.45 "	4.50 "	5.56 "
	4.28 "	5.35 "	6.45 "
	Sing Sing		
	5.00 P.M.	6.05 "	6.45 "

A Time-Table of the Elevated Railroad in 1872, Showing the Limited Service It Afforded and the Stations at Which It Stopt.



THE NEW YORK

ELEVATED

Railroad.

TIME TABLE.

Change of Time.

October 16th, 1872.

Between Battery and 29th St.

The publication of this article was brought about by the accidental finding of a time-table of the elevated railroad as it ran in 1872. Its route extended from near the Battery up to 31st St.; leaving it at 31st St., a short walk brought the traveler to the old Hudson River station near 10th Ave., whence the local trains for stations on the Hudson River Railroad used to start. It took some time to get from 31st St. to lower New York in those days, as there were no trolleys and street cars and the omnibuses were horse-drawn. The omnibuses in those days averaged not much more than five miles an hour, so for dwellers on the banks of the Hudson the steam-driven elevated road shortened their trip downtown probably not less than thirty minutes, a very important gain.

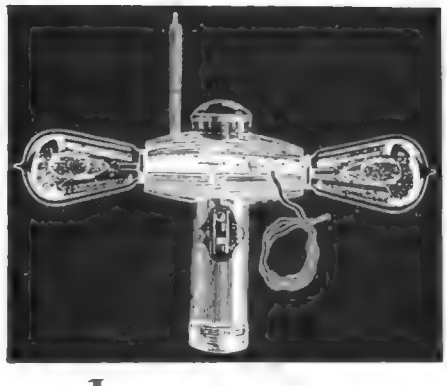
Immense opposition to the project was excited, and the courts were kept busy with litigation in damage suits for many years.

The first practical operation of the road was by dummy engine, which was certainly obnoxious to the residents, and the effect of the discharge of smoke and steam was perceptible on awnings and painted work of houses all along the line.

Among the early cars used on the road were some with specially low centers of gravity, the floor between the trucks being carried far down almost to the level of the roadbed. The end compartments were reached by short stairways. People were dreadfully afraid the cars would fall over sideways. Of course there was no more danger of this on an elevated structure than on the ground, and such an accident on the ground is almost unheard of.

New Lamp "Fuse Tester"

Unless some form of tester (usually crude and home made) is available, it is at present common practise to replace with new fuses, all the fuses of a cutout box in which one fuse has blown, waiting for a future opportunity to make a test to detect the blown fuse or fuses, and to replace in stock the fuses which have not operated.



This Useful Device Comprises a Flashlight and Two Standard Edison Sockets in Which the Test Lamps Are Placed. The Flashlight Can Be Used to Illuminate the Fusebox, and by Means of the Lights Shown, the Fuses Tested Rapidly and Accurately, the Lights Flashing Up if the Fuse Is O. K.

An appliance designed to do away with waste of time and money to discover a blown fuse is here illustrated.

Essentially, it consists of a device to test fuses *in situ*, with safety, while the back of fuse is illuminated by the light from a dry-cell flash lamp. The tester is held in one hand, the light flashed on, and the necessary contacts are made by means of the two-contact points shown in the illustration—one a stiff heavy rubber insulated wire—and the other a rubber insulated flexible wire. The result of the test is immediately apparent by the lighting or remaining dark of the two test lamps arranged in series.

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New Science Wrinkles

SEEING THRU THE SKIN.

Prof. Lewis Farigoutte of the University of Paris has recently written a book, which seeks to prove that the eyes are not absolutely necessary for seeing things, and in fact, that an individual can see even without his eyes. Prof. Farigoutte has supported his theories with some very remarkable facts, and altho the medical authorities seem to view the story with considerable skepticism, it may be, that Prof. Farigoutte will eventually convince the medical fraternity.

There are, as every individual knows, and as has been described from time to time in this magazine, many different varieties of nerve endings in the skin, which modern histologists have demonstrated, as being in the outer layer of the dermis (the sensitive layer of skin beneath the epidermis).

There is another form of nerve ending described as occurring in the epidermis of a pig's snout; these nerve endings are composed of microscopical expansions interposed between the cells. Prof. Farigoutte says that these forms of nerve endings have to do with the sense of touch, and some of them are also associated with the sense of vision. He pictures these microscopic expansions as being little eyes, as found in many invertebrates, and thus, that a collection or a group in certain parts of the body, would constitute a compound eye.

Can We See with Our Skin? Professor Lewis Farigoutte, of the University of Paris, Claims That Tests Have Demonstrated That the Skin Contains Peculiar Nerve Terminals Which Act as "Eyes"

The visual impulses originating from the skin are then transmitted via the central nervous system, in the same manner, that the impulses from the eye are conveyed to the optical lobe or any other center of sight.

Prof. Farigoutte has conducted his researches on hypnotized subjects, who were blind, and is willing to stake his reputation upon the truth of his discovery. If such a discovery is absolutely authentic, it at least suggests a way for the blind to see, when they have been properly trained for this work.

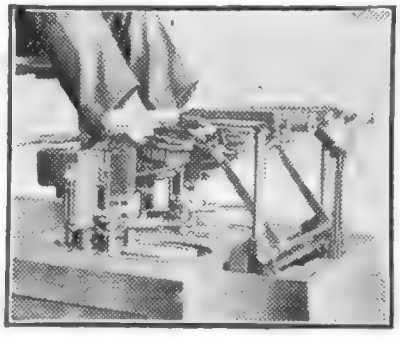
NEW VACUUM CLEANERS FIT BODY

This miniature vacuum cleaner weighing but six pounds is slung on the left hip of user and travels about with him during his cleaning operations. The portability of the machine and the freedom that it gives the operator, make it particularly useful for difficult indoor work, such as the cleaning of deep mouldings in plaster or books in large libraries and for all general purposes. It is claimed, that efficiency is gained by its light weight and by its going everywhere with the operator. Quite remarkable examples of its efficiency and rapidity of its operations are furnished by the work it has done in the library of the University of Pennsylvania and in the Philadelphia National Bank. It would be hard to find any place where it would not prove exceedingly useful.

Our Cut Shows the General Service Vacuum Cleaner and Operator, Illustrating the Method of Attachment to the Person, and Showing How Conveniently it Can Be Manipulated.

A MECHANICAL SHOEBLACKING MACHINE

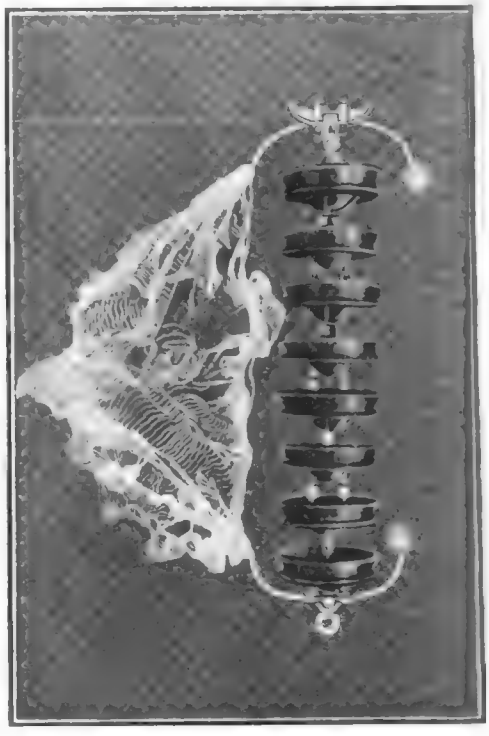
It may be the fortune of some of our readers to seat themselves in a comfortable chair and have their shoes polished by machinery. The illustration shows one of the recent, highly perfected appliances for doing this necessary work, and the distinctive peculiarity of this machine is that its operations are complete. In some of the machines a man has to be in attendance; he holds the rotating brushes in contact with the shoes and gives the final artistic touches by the regular hand appliances. But the machine which we illustrate here is a completely automatic mechanism. The coin is inserted in the slot and the machine does the rest; dusts the shoes, dries them, polishes and brushes to a shine and finally rubs with a cloth to give the finishing touch to which we have now become accustomed. One and a half minutes only are required for the process. The machine falls in the class of automatic vending machines, and its exploiters believe, that it will obtain very extensive introduction and appreciation from the public.



A Mechanical Shoeblack That Cleans and Polishes Your Shoes in One and a Half Minutes and Expects No Tip for Doing It. It Is Supposed to Do the Work of Four Active Boys.

TESTING INSULATORS

The very high tension electric circuits now used for long distance power distribution require the highest grade of insulators. These insulators are made of the most carefully selected material and are rigorously tested before leaving the factory or before use. They are subjected to a very high potential until the point called the "flashover" is reached, when the spark is discharged and leaks from terminal to terminal outside of the insulator.



A Spectacular High Voltage Test Conducted on a Suspension Type Insulator, Such as Is Used on High Tension Transmission Lines. The Voltage Is Increased During the Test until the Discharge Breaks Down the Air Dielectric and Flashes Over. The Insulators Here Shown Are Quite Large Affairs or About as Big as Dinner Plates, and the Flashover Took Place when the Voltage Was Raised to a Potential of 430,000 Volts A.C.

This discharge is kept up for a long enough period to detect any weakness in the porcelains. Another test which may be said to be applied once for all on a standard shaped or experimentally shaped insulator, is called the "design" test, to determine whether the shape of the insulator is such as to restrict the discharge to the air. The test is made still more conclusive by sprinkling the surface of the insulator with water so as to make a rainy day test.

The cut shows a wonderful aerial discharge produced during the testing operation of some insulators at a potential of 430,000 volts A. C.

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New Water Wheel Electric Plant

The Photographs and Diagram Herewith Show a New and Novel Form of Floating Water Wheel Electric Generating Plant. It is Anchored in a Convenient Stream and One of the Revolving Paddle Wheels is Caused to Drive an Electric Dynamo to Supply Lamps, While One of the Wheels May Drive Pump or Other Device.

Considerable attention has been lately given to supplying farmers all over the country with power stations for their domestic needs. Some of the largest electric companies and wind mill manufacturers have been at work along this line.

We illustrate a special undershot water wheel for the farmer's use. This is an undershot wheel, carried by pontoons, so that the structure can be floated on a running stream with the lower blades of the wheel immersed in the current. Five inches of water is enough to float it, and no matter how much the stream may rise or fall due to freshets, the wheel will always be uniformly immersed because of the supporting frame being carried on floating pontoons which our diagram shows, and which rise and fall with the water keeping the lower blades of the wheel at a uniform depth.

The plant can be variously arranged. Our diagram shows a water wheel at the right, which by multiple chain and sprocket wheel gearing, drives the dynamo seen at the left. The dynamo proper may, of course, be driven by a leather belt, but the multiplication of the speed of the slow rotating water wheel is effected by the very efficient chain-drives, which have obtained such wide popularity among the mechanics of the day.

The electric generator supplies current for a number of purposes about the house and barn, including electric lighting.

We show at the left a second water wheel. This wheel has no gearing connected to it for increasing the revolutions per minute of its driven machinery, and is supposed to directly actuate a pump for pumping water.

The advantage of such plants as these is that 24 hours of low power may be accumulated by storage battery or water reservoir so as to enable the power to be used at a higher rate for a few hours, if such may be necessary.

One illustration shows the duplex water wheel pontoons ready for launching. Another shows the interior machinery, while the diagram shows clearly the multiplying gears.

The Smallest Telephone

This portable telephone, no thicker than an average pencil, is being manufactured in Germany. It is called the "Phonophor." When telephoning, simply stick the receiving end in your ear and talk into the double-disked mouthpiece after you have attached the instrument to a city telephone wire. A register for ringing up the number of calls is also part of the apparatus. As yet, the authorities have forbidden its use, altho it has been patented. The young lady is shown demonstrating how light the "Phonophor" is, and how portable.

Here We Have the Latest German Invention—an Extremely Small Yet Complete Telephone Set to Aid the Deaf in Hearing Better. The Receiver Which Fits into the Ear is Smaller Than an American 5c Piece. The Microphone and Battery are Carried in the hand bag.

The miniature receiver is smaller than the 5 pfenning piece which is about as big as an American five cent-piece.

The "Phonophor," probably the smallest telephone of electro-magnetic type constructed so far, is of considerable interest to all electrical and telephone men, as aside from the de Lange thermo-telephone, in which a fine U-shaped platinum wire is rapidly heated and cooled in syntony with the fluctuations of the telephone current, this receiver represents a most remarkable piece of work when it is considered that in this small compass are included two electro-magnets, wound with extremely fine wire, probably about No. 50 B. and S. gage.

The permanent steel magnet of the receiver is enclosed in the longer chamber shown. It is here shown as a deaffone.

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Editor's Mail Bag

WE ARE DETERIORATING

EDITOR SCIENCE & INVENTION:

Having been a reader of your magazine, virtually since its inception as *Electrical Experimenter*, I have been enabled to note the gradual metamorphosis of *Science & Invention* from a technical publication to a purely juvenile science periodical.

The present status of your publication is not up to the original standard which has been maintained in the past. This has been the unanimous opinion of numerous former readers of the magazine, who evince no desire to resume subscription.

I sincerely trust that *Science & Invention* will in the near future represent a publication of interest to the technically inclined of higher plane than most of its readers now represent.

Yours respectfully,
SIMON MENDELSOHN.

Chicago, Illinois.

(Please realize in the first place that with a magazine such as SCIENCE & INVENTION *you have, editorially speaking, to satisfy a great variety of desires on the part of the readers. If you don't think so, the next time you are visiting your Public Library or oftentimes when traveling, you will be surprised at the great variance in age of the people whom you see reading a magazine of this class. It is certainly evident therefore, that if we publisht a magazine edited in the fashion you suggest, that we most surely could not expect to obtain the support of the younger science students. Not only this, but you must not forget that the average layman, and by this we mean people whom you meet every day anywhere, and who have a certain amount of liking for scientific subjects, will not—and we might as well say cannot—read the heavy technical articles written in the usual scientific style for deep scientific scholars.*

We feel sure from our past editorial experience and speaking of course from the business viewpoint—as no magazine can exist if the circulation and advertising features are not carefully watched and properly handled—that if you were to rely on the really very small number of pure science readers who would like to see a monthly magazine filled up with long, dry articles, on such subjects as Biology, Medicine, Entomology and so on thru thirty or forty subjects which the average lover of science knows very little of, you would find yourself high and dry on the island of bankruptcy before long.

Our experience in interviewing many people in all walks of life who read SCIENCE & INVENTION *every month and like it,—and this includes doctors, lawyers and engineers, men who had the benefit of a college education and know something at least of true science,—only gives us a stronger resolve to endeavor to present in each succeeding issue of our journal, the latest and most interesting happenings in the world of science and in a palatable manner so to speak; the average reader of a magazine of this type we have found, will not sit down and read page after page of dry text. What he likes to look at first, are the pictures and after that he will probably condescend to read 500, 1000 or possibly 1500 words once in a while if it is popularly written.*

We try to write our articles or have them written in as popular a style as possible and also in an entertaining manner and they must be authentic.

You say, that the present status of this publication "is not up to the original standard," and we certainly do not agree with you at all—for many of our ablest readers, men of wide experience and reading, have repeatedly told us that SCIENCE & INVENTION *has improved progressively each year, and to the best of our belief we never have publisht such an excellent variety of popular scientific articles, written by eminent scientific authorities, as we are publishing today.—EDITOR.)*

THIS JOKE IS ON US

The biggest joke you ever publisht is your announcement occupying the center of your scientific humor page.

You state there that "copied" jokes have little or no chance—while all around your announcements are copied jokes, and ye gods! of what ancient vintage.

—C. J. BALL.

Fort Wayne, Ind.

(True, friend, very true. We know it, but what can we do? Print none at all? Now suppose, Mr. Ball, YOU sit down and send us a few real ones—just think, $3.00 and $1.00 per!!—EDITOR.)

We Herewith Present the Editor's Mail Bag Which We Publisht as a Monthly Feature Some Time Ago, but We Have Received Such a Number of Letters Recently Commenting on SCIENCE & INVENTION and Its Policies, That We Have Decided to Publish a Number of These Letters Each Month. Write and Tell Us What You Think of SCIENCE & INVENTION, but Try and Limit Your Discussion to 200 Words or Less, as We Want to Publish as Many of These Letters on This Page as We Can. Address All Letters for the Editor's Mail Bag to—Editor, SCIENCE AND INVENTION, 233 Fulton St., New York City.

HE LIKES DeQUER'S ARTICLES

Editor SCIENCE & INVENTION:

Your magazine is certainly a wonder; the articles are real gems, every one of them.

In your November, 1920, issue, you have one article in particular, viz: "Dr. Pringle Discusses Life," by John De Quer, on page 726. It is so far ahead of all other articles discussing "Life" that there is absolutely no competition. I have heard so-called learned men get up at various meetings, and cuss and dis-cuss this subject; they usually wound up just exactly where they started, but this fellow De Quer really takes you some place and don't leave you either to get out of a wilderness alone.

The mistake most authors make on this subject "life" is that they discuss it a great deal like they discuss "God," you have to take everything on "faith;" it is all theories and no facts.

The only thing that I did not like to the story is that it is like everything else and came "to an end;" let us hope that the Dr. will soon take care of the patients he had in the office, eat his luncheon, and take up the discourse again.

Yes, we earnestly hope, that there will be many more such scientific articles along the same and similar lines. And the stories on other subjects in your magazine are of the same high type and large calibre.

Cordially and Sincerely Yours,
DR. FRANK A. WOODWARD, M.D.,

Los Angeles, U. S. A.

WHAT HE LIKES

Editor SCIENCE & INVENTION:

The parts of your magazine I like best are Electro-Experiments, Chemistry, almost all kinds of experiments.

I like the "How to Make It" Dept. Articles like "The Human Aura," "The Moon Rocket," and "In 1999," and the Scientific Stories cannot be beat.

As the "Electrical Experimenter" your magazine stood in a class by itself, but it seems to be getting more like the other "new invention" books on the market until the May issue. I like the May number better than any other one, since you changed the name to *Science & Invention*.

It is still the best magazine of its kind on the market.

Please give us more *Science* and less invention. The Editorials, too, are fine.

You asked for criticism. This is mine.

C. E. GIBBS.

East Peoria, Ill.

WHY WE DO IT

Editor SCIENCE & INVENTION:

I would like to make a suggestion in regard to your excellent publication, *Science & Invention*. When you tell what is going to appear in the next issue why don't you print it? As an example in the April number under the heading, "A Few May Articles," there were no less than seven articles given that did not appear in the May number.

B. J. KINGSTON.

Tippecanoe City, Ohio.

ANSWER

(We thank you for your suggestion, but altho at times we seem to see our way clear to publish the articles which are listed, it frequently happens that something new in the scientific field interests the masses and, therefore, we have to get there and get there quickly if at all, hence some of the articles which are listed have to be removed. It is for this reason usually that articles which are announced sometimes do not appear until at some future date when we see our way clear. Nevertheless, all the articles announced are usually publisht eventually.—EDITOR).

WANTS MORE "MONSTERS"

Editor SCIENCE & INVENTION:

The article, "Monsters of Long Ago," is, I consider one of the best which has appeared in *Science & Invention* for some time. It is more of the nature of "Science," than the great portion of the magazine which is devoted to Radio, Electricity, etc. I am surprised that this magazine like others has, turned more to the spectacular and extraordinary instead of following pure science.

Let us then have more Geology, and other natural sciences.

They are not in accordance with the new title which the magazine has assumed.

THEODORE H. COOPER.

Batavia, N. Y.

(Correct; we would like to do so, but the majority of our readers want—unfortunately—"sugar-coated science." They abhor "dry" science articles, and if we were to print only such our circulation would be 20,000, instead of 200,000, and that means that we could not print all the good things we do now. Only by having a large circulation can we hope to keep up printing the variety we give now, to please every reader, so that each one will find at least a few articles that he likes.—EDITOR.)

A HANDSOME BRICK—BUT

Editor SCIENCE & INVENTION:

I enjoy your magazine very much. However, I am afraid that it is getting to be too much on the order of a kid's magazine. Do not be mistaken; it is not as good as it was. I am sorry that it is getting worse for it can be the best magazine on the U. S. files. No doubt some of your proposed inventions would bring a tidy sum if developed but they will never get you any place as they are now. Several people have said, "H. Gernsback can make more money proposing such things than he can by developing them." I am of the present opinion that he is right.

Have some more articles by T. O'Conor Sloane, they are *fine*.

HAROLD C. RISOR.

Lompoc, Calif.

(True. True. The prophet was always liked in every country but his own! Just the same our "theories" are coming true right along.—EDITOR.)

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Home Electrics

By G. L. HOADLEY, M.E.

Electro-Magnets and the Laws of Magnetism

NEARLY everyone has seen or heard of Horseshoe Magnets. They are commonly seen on the flywheel of the Ford automobile, in the ordinary telephone generator for ringing up "Central", and its uses

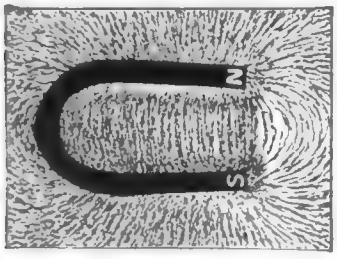


Fig. 1—Magnetic Lines of Force About a Horseshoe Magnet, as Shown by Iron Filings. Blueprint or Photo Printing Paper is Very Useful in Making Charts of the Fields About Different Magnets.

are many. Many other forms or shapes of magnets are in use, but the Horseshoe type, shown in Fig. 1, or some modification thereof, such as the door-bell magnet, is very commonly met with.

All are familiar with the attraction or pull exerted by a magnet on iron or steel near it. Fig. 2 shows iron or steel nails attracted by a magnet, and this property is utilized in many ways—one of the most important being the handling of scrap and other iron by huge electro-magnets. Let us examine for a moment the nature of this magnetic force. If a sheet of unglazed paper be dipt into a tray of melted paraffine and this paraffined paper is laid on top of a horseshoe magnet and then iron filings are sifted over the paper, while gently tapping it with a lead-pencil, the filings, being attracted by the magnet, will arrange themselves in the direction of the magnetic lines of force as shown in Fig. 1. Then on warming the paper so as to melt the paraffine the filings will be fixt in place. This gives us a picture of the UNSEEN lines of force which surround a magnet.

Kinds of Magnets. There are three kinds of Magnets. The natural magnet, or loadstone; the permanent steel magnet, and the electro-magnet.

Weak permanent magnets can be made by simply rubbing a piece of iron or steel with a natural magnet. Stronger magnets will be made by stroking a hard tempered piece of steel with another strong permanent magnet. Probably, the strongest permanent magnets can be made by inserting one limb of the Horseshoe in the upper end of a spool wound with insulated wire, then turn on the current, tap it, turn off the current, insert the other limb in the other end of the coil and repeat the operations taking care to give opposite current direction for the two poles by this method.

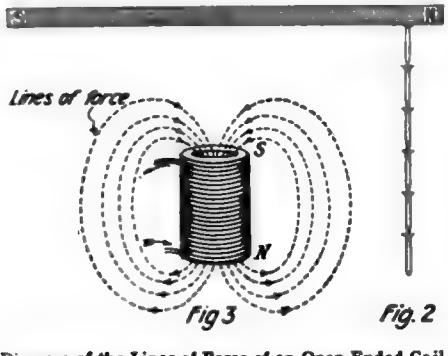


Diagram of the Lines of Force of an Open Ended Coil of Wire Without a Core. At Right—Bar Magnet Supporting Chain of Iron Nails.

If a number of turns of insulated wire is wound upon an iron bar it makes a strong electro-magnet when a current of electricity is sent thru the coil in the spool referred to above previously. A diagram of its magnetic lines of force is shown in Fig. 3. Since the magnetic effects obtained with the electro-magnet are identical with those gotten from the permanent magnet, we know that a current of electricity can be made to produce magnetism. Fig. 4 shows a diagram of the UNSEEN magnetic lines of force surrounding a straight wire carrying a current of electricity.

Magnetism differs from the electric current chiefly in the fact that it cannot be insulated. Magnetism will pass thru air, stone, clay, mica, or any insulating material, while an electric current will not to any appreciable extent.

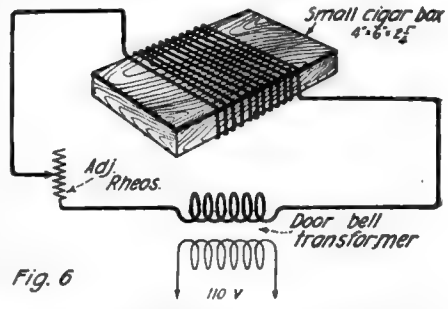
Magnetic Screens and Their Application. Oftentimes, it becomes necessary to shield some delicate instrument from a magnetic field nearby. An iron cage or box, completely enclosing the device, will effectively shield it from external magnetic influences.

Fig. 7—Caught in Trolley Wire. Be Careful Not to Get Shocked in Rescuing Him. Heavy Rubber Gloves or a Dry Coat, Dry Wood, Sticks, Etc., May be Used, but Don't Touch the Victim's Body With the Bare Hands.

The enclosing box does this by virtue of the better permeability of iron than air. The magnetic force lines take the easier path and travel around thru the iron rather than across thru the air spaces and enclosed device. A soft iron case completely enclosing a watch will effectively protect it from the stray magnetic field of a dynamo.

In these days, the rapid introduction of Electric Railways, the proximity of telephones and telegraph wires, and the rapidly extending use of electricity in the home for the various electrical appliances, make it sometimes necessary for the average person to either shield his watch from these outside magnetic effects or else preferably to carry a non-magnetic watch. It may be obtained in all the various grades. The Paillard non-magnetic watch is both non-magnetic and non-oxidizable. It differs from the ordinary watch in that the hairspring and balance are made of Palladium metal instead of steel. Palladium is one of the rare metals and is non-magnetic, yet possesses the tensile strength and other necessary properties to give satisfactory service.

Demagnetizing Process. Wherever watches are repaired or sold, commercial demagnetizing coils are often to be found. Fig. 5



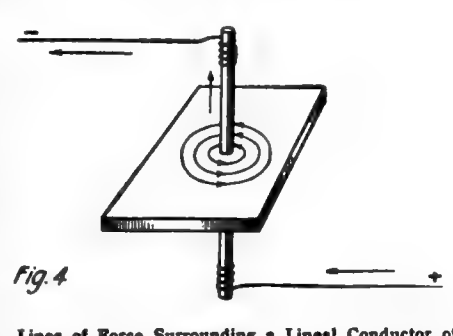
A Simple Demagnetizing Apparatus for a Watch. It is Designed for Operation on Alternating Current.

shows a watch demagnetizing coil. The process of demagnetizing a watch with it is as follows: Connect the coil to a lamp socket using *alternating current.* Hold the watch flatwise horizontally within the center of the coil and close the key, s. Then, *slowly* pull the watch out of the coil horizontally for a distance of 18 inches from the coil. This process may have to be repeated several times to remove all traces of magnetism. To test for magnetism in a watch, place a jeweler's or else a pocket compass directly above the balance wheel in the back of the watch. If magnetic, the compass needle will vibrate back and forth rapidly. If no magnetism exists, the compass needle will remain quite still.

Construction of a Demagnetizing Coil. It is possible to build a demagnetizing coil which will give satisfactory service. It may be constructed in several different ways. Fig. 6 shows an outline sketch of a simple coil, suitable for demagnetizing watches and other small objects. Procure a small wooden cigar box to serve as the core of the coil. Remove the ends of the box and wind it with about 150 feet of No. 24 cotton-covered copper magnet wire. This will give roughly four layers, 8 inches lengthwise of the box and makes 130 turns. Connect an adjustable rheostat or resistance in series with this coil and place the entire device across the low voltage side of a bell-ringing transformer. To demagnetize the watch, lay it in the box, close the circuit to the transformer and gradually cut in resistance with the rheostat till the current is practically zero. Test for magnetism as previously explained and repeat the process if necessary.

Accidental Shocks—How to Avoid Them. In spite of all precautions, electrical circuits which are normally insulated from the earth

(*Continued on Page* 356)



Lines of Force Surrounding a Lineal Conductor of Current. This Can Be Demonstrated by Means of Iron Filings on a Glass Plate or Piece of Cardboard.

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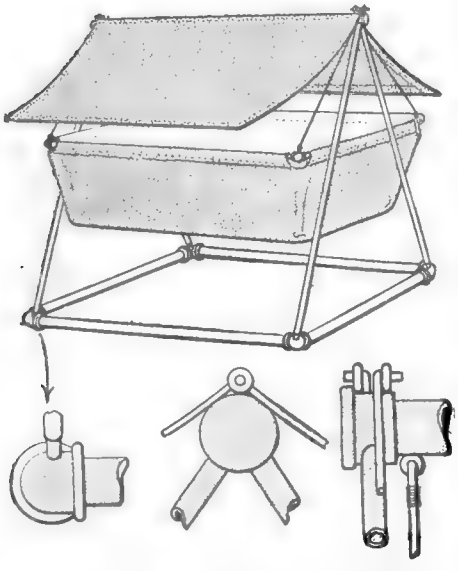
Home Mechanics

Conducted by WILLIAM M. BUTTERFIELD

LAWN SWING FOR BABY

The swing shown in our plate is professional and shop-made in appearance, yet it is an easy home-mechanic sort of thing to construct. It is made entirely of metal and canvas. First there is a square frame

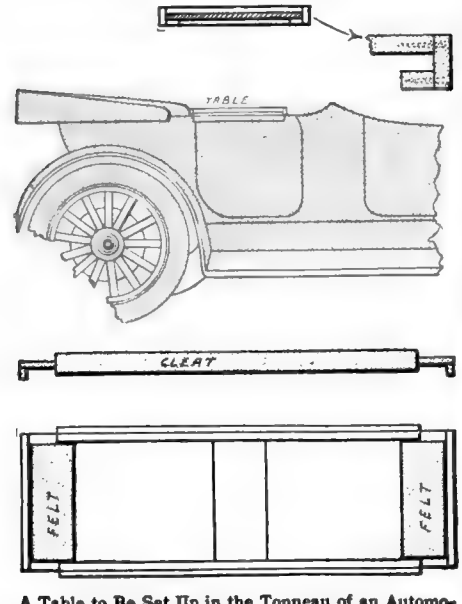


A Comfort for the Baby in Dog Days; a Home-Made Hammock in Which He Can Sleep and Play.

of ¼" gas-pipe, having ordinary pipe elbows at its corners, which supports the canvas-pocket swing; then a base frame similarly constructed of ½" gas-pipe and elbows; a top rail of ½" pipe with common caps; four rods connecting the base frame and top rail of ¼" pipe—their ends threaded in holes in the elbows and caps as shown; two 3/16" rods, bent awning-frame-fashion, retaining two awnings, either of which turns over back against the other when attending to baby's wants; two ⅛" flexible wire rope swings, ten screw eyes for awnings and swing ropes, and, finally, the canvas awnings and canvas pocket swing. This little device is simple, safe, sure and cleanly.

AUTOMOBILE TABLE

A day or afternoon outing trip in the auto is conducive of that all-gone feeling, commonly known as hunger, yet many an excursionist returns home, in these days of income-and-profit-taxes, with hunger unappeased, because they do not like to climb humbly down from their car and partake of food on the grass in plebian picture fashion, or partake of a sandwich out-of-hand in the car—a proceeding that always seems to have a degrading aspect. If one could sit in state, anywhere, and eat from a well appointed and decorated table forming a natural part of the equipment of the auto, the act would be as pleasing, satisfying, and dignified, as lunching in a public dining room. Taking this view of the situation, the author has devised such a table, which is shown in the illustrations, asking as a reward for the forethought there shown, that some home mechanic, constructing such an apparatus, will provide him with the means of seeing his particular table in actual use, and even experimenting with its savory load.



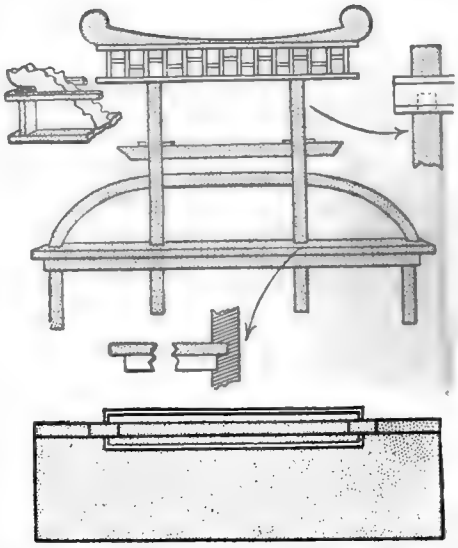
A Table to Be Set Up in the Tonneau of an Automobile, So That the Picnickers Can Sit in Comfort on Spring Cushions While They Eat.

The device forms, when closed, a flat board-like mass, that lies unobtrusively on the floor within the tonneau between the two back doors, out of sight and out of the way. When in use the sliding ends are drawn out and hooked over the opposite sides of the body, with the felt on and against the smooth lacquered metal, as a precaution against scratching or marring. Hubbie can go as far as he likes with the table, making it of real mahogany, just as wifie can spread with the napery and table fixings, for the thing is going to catch on and become popular; it is just the thing autoists have been looking for.

TENNIS COURT BENCH

Out of old Japan has come the characteristic water gate, common in most Japanese gardens as a striking feature of decoration. In our plate we have conventionalized the top of the gate, so as to form a pair of pockets for holding rackets and tennis-balls, yet still having it retain its striking decorative quality. With its two posts, it forms the back of the design for a tennis bench, shown in the figures. The idea is to have two benches, one at either end of the court, constructed in a vigorous, not too highly finisht, manner, and stained to represent wood that has been exposed for years to the weather—oil and creasote is a good finish and out-of-door preservative.

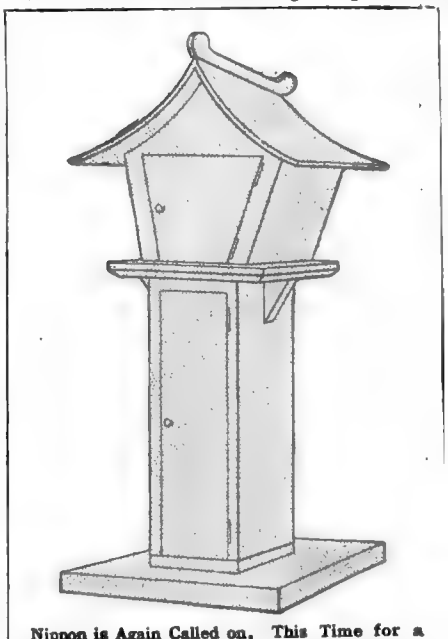
The backs, for effect, should be at least seven feet high, with the proportions, about as we have drawn them, for all of the other parts.



A Japanese Structure to Adorn the Tennis Grounds, Holding Rackets and Tennis Balls, and Providing a Bench to Sit On.

CROQUET EQUIPMENT HOLDER

In one of the cuts we have displayed a device, patterned after a Japanese lantern, for holding wickets, balls and mallets when they are not in use on croquet grounds. It is made of wood with a box-like top and base closed with doors. The outside of the device is painted and heavily sanded to make it appear like stone—just as wooden stoops were at one time painted and sanded for a like purpose. A device of this kind, carefully made, first saturated with oil and creasote and allowed to dry thoroly, will, when finally painted and sanded, last for many years, growing brown and mellow with age. If a concrete or flag-stone base is sunk into the sod for the foot of the lantern to rest upon, there will be no sinking in winter or rainy weather, or bother with the lawn mower when cutting the grass.



Nippon is Again Called on, This Time for a Cabinet for the Croquet Lawn to Hold Balls, Mallets, and Wickets

IMPORTANT:

TO NEWSSTAND READERS

IN order to eliminate all waste and unsold copies it becomes necessary, beginning with this month, to supply newsstand dealers only with the actual number of copies for which they have orders. This makes it necessary to place an order with your newsdealer, asking him to reserve a copy for you every month. Otherwise he will not be able to supply your copy. For your convenience, we are appending herewith a blank which we ask you to be good enough to fill in and hand to your newsdealer. He will then be in a position to supply copies to you regularly every month. If you are interested in receiving your copy every month, do not fail to sign this blank. It costs you nothing to do so.

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Popular Astronomy

By ISABEL M. LEWIS, M. A.

of U. S. Naval Observatory

A Model of the Solar System

IT may be helpful to us in our efforts to form some idea of the relative sizes of the various members of the sun's family, and of the extent of the solar system as a whole, if we understake to construct a model of the solar system, which model will show in the correct proportions, the sun, the planets and their moons, and the planetoids or asteroids, as well as their relative distances on the same scale, and the distance of the system from the nearest star.

As we are all familiar with the small school globes, six inches in diameter, let us take one of these to represent our planet Earth. The diameter of the earth is very close to eight thousand miles, so we take as the scale for our model of the system six inches to eight thousand miles.

Venus, on this scale would be represented by another globe only one-fifth of an inch less than the earth-globe in diameter.

Mercury would be a ball two and three-tenths inches in diameter, a little smaller than a tennis ball, and Mars would be three and two-tenths inches in diameter—just slightly larger than a baseball. These four balls, then, we may take to represent our terrestrial planets, as they are called, Mercury, Venus, Earth and Mars.

The asteroids, or planetoids, which lie between the orbits of Mars and of Jupiter, range in diameter from about five hundred miles for the largest to five or ten miles for the smallest. There are few asteroids over one hundred miles in diameter. The four largest are Ceres, Pallas, Vesta, and Juno, and their diameters, as measured by Prof. Barnard, are 485, 300, 243 and 118 miles respectively. On the scale we have chosen Ceres would be a small marble (3/8 of an inch in diameter) and Pallas we might represent as another still smaller marble. The other asteroids we might represent by shot or beads of various sizes, or in the case of the very smallest, five miles or so in diameter, by grains of sand. The great majority of the asteroids are probably between ten and fifty miles in diameter, so most of them would be grains of sand or very small shot in the model we are constructing.

Coming now to the group of major planets, which includes Jupiter, Saturn, Uranus, and Neptune, we find that we are dealing with bodies far larger than the members of the terrestrial group.

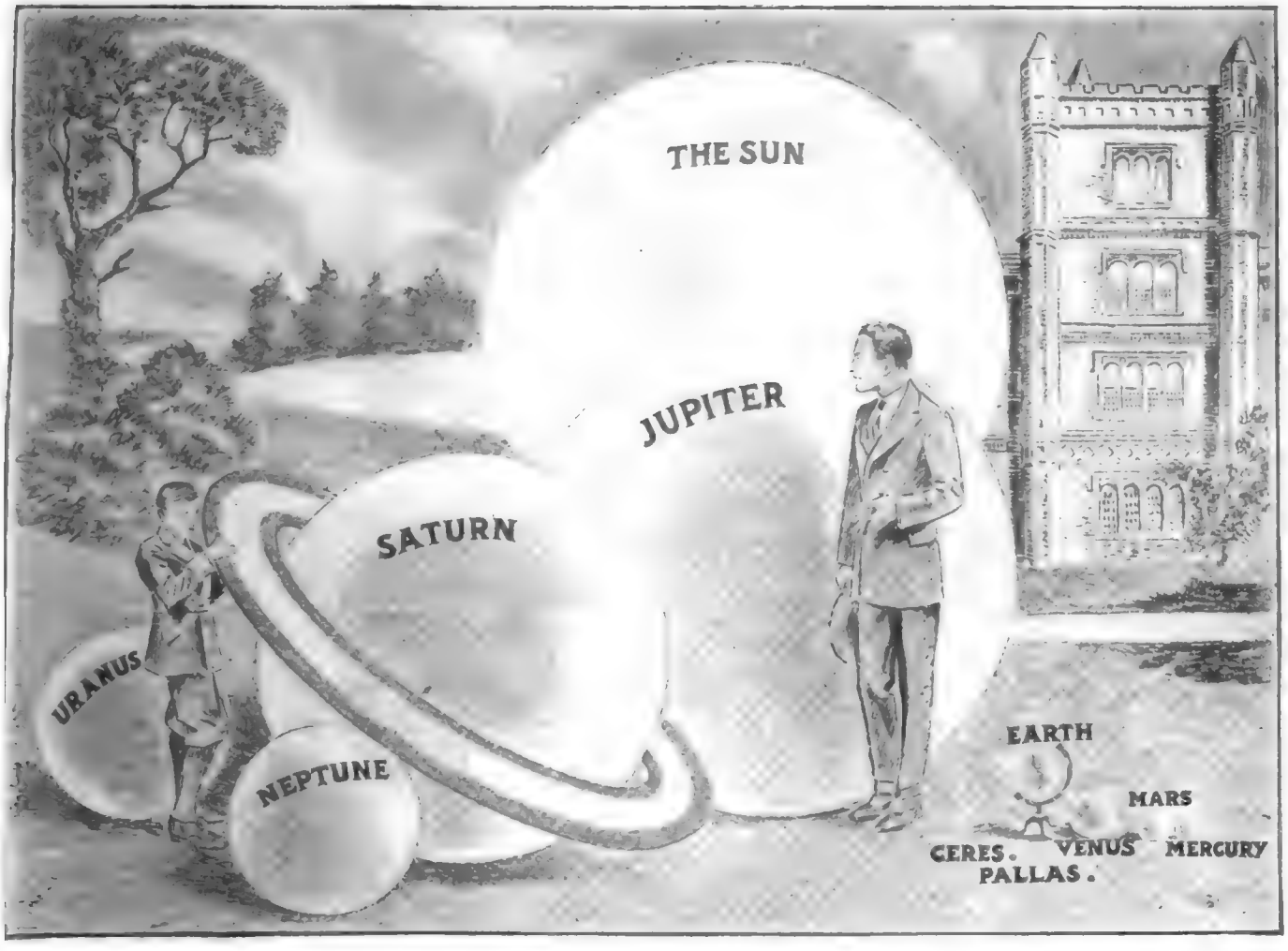
Jupiter, the largest planet in the solar system, will be in our miniature system a huge globe with a diameter of about five feet six inches, which is about the average height of a man.

Saturn will be a globe four feet seven inches in diameter, standing as high as the average twelve-year-old boy.

On the scale we have chosen both of these planets would appear considerably flattened at the poles, the polar diameters being on our scale several inches shorter than the equatorial diameters, but we will take the average diameters for these globes.

Tho the ball of Jupiter is considerably larger than the ball of Saturn, we find our model of Saturn is a far more awkward body to handle, for we must add to it a system of rings, unattached to the ball of the planet of course, which ring-system is made up of three parts, an inner dark ring, a central ring as bright as the ball itself, and an outer ring, that is less bright, and that is equal in width to the inner ring. The inner edge of the inner ring

(Continued on Page 361)



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The Illustration Presents the Coup D'Oeil of Mrs. Lewis's Illuminative Article. The Relative Sizes of the Members of the Solar System Are Indicated. Some Have to be put in Perspective as the Size of Our Page Would be too Small to Contain the Sun. It is Put Modestly in the Background Alongside of a Four Story Building Which Tells the Story of Its Relation to the Pigmy Planets Which Wait Upon Its Attractive Powers.

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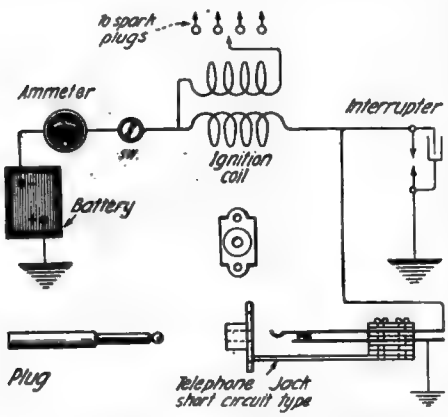
MOTOR HINTS

First Prize $25.00

ELECTRICAL LOCK

The attached diagram shows an ordinary telephone jack of the short circuit type used as an automobile lock. The telephone jack is mounted back of the instrument board in a vertical position, out of sight, so that the plug can be conveniently inserted in the jack. One spring of the telephone jack is grounded and the other one is connected to the wire which connects primary of the ignition coil to interrupter.



A Simple System of Locking an Automobile by a Short-Circuiting Jack Switch

Withdrawing the plug operates the lock by closing the shunt circuit around the interrupter which renders same useless as far as opening the primary circuit is concerned. If ignition switch is closed in an attempt to start the engine, the ammeter will indicate ignition current, showing that the circuit is not open, but there will be no spark at the spark plugs.

In the normal operation of the car the plug is inserted in the telephone jack, thereby opening the shunt circuit around the interrupter, and left there as long as the car is to be operated. After stopping the engine the driver simply removes the plug and takes it with him with the assurance that the engine will not be started until the plug, which he has, is inserted in the telephone jack.

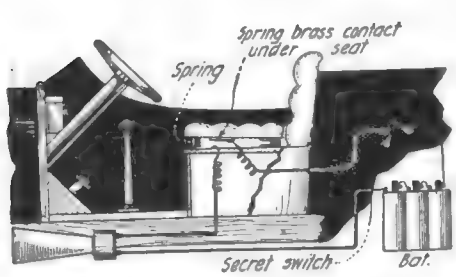
Handling the plug is much easier than operating a key in an ordinary lock. The telephone jack can be obtained from any telephone company or from most stores handling wireless or telephone apparatus.

Contributed by J. S. KINNEY.

Second Prize $15.00

KLAXON SOUNDS WHEN THIEF SITS DOWN

The principle of operation of this alarm system on the automobile is as follows: When the owner gets out he throws in the "secret switch." Now if anybody gets into the car he will sound the Klaxon as soon as he sits down. He no doubt will soon become alarmed because of this unexpected noise and will at once start to make a hasty retreat.



How to Frighten an Automobile Thief. The Klaxon Sounds When He Occupies the Driver's Seat.

Contributed by C. S. CIERPIK.

NOTICE—CONTRIBUTORS ! ! !

We have not been at all satisfied with the class of suggestions we have been receiving lately in this department. Most of the devices that are suggested are very crude, and while some of them may be original, they are so impractical that not one in a hundred motorists would think of using or installing such a device. There is, however, one device that is needed badly which apparently has as yet not been invented. We refer to a device that would prevent stealing of motor cars. In the City of New York alone, there are stolen every day an average of 15 cars. The average for the entire country varies from between two to three hundred cars each and every day. This is a terrible loss and must be stopt at all cost.

For the next few months we will, therefore, give prizes only to such devices as prevent stealing of cars. We have publisht a few good ones in the past, but we feel sure that there are a good many others that should prevent thefts. It should be remembered always that motorists do not wish complicated and cumbersome devices; something that can be put in place quickly, and that can be removed just as quickly, is what is wanted. The device should, of course, always be secret so that the casual crook will not know how it is used. Variations of the device should be possible so that even after publishing such a device and giving it the fullest publicity, still it could be attached in such a way as to defy detection by the average man.—Editor.

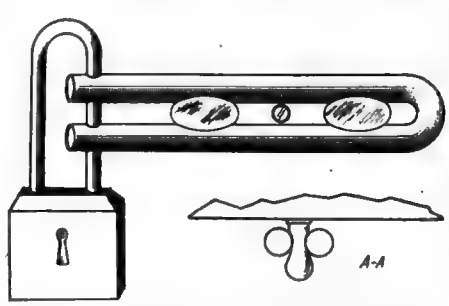
FIRST PRIZE.....$25.00
SECOND PRIZE..... 15.00
THIRD PRIZE..... 10.00

All other accepted articles, which win no prizes, will be paid for at the rate of $2.00. Articles submitted should not be long ones. About one hundred to two hundred words will suffice. Address all manuscripts to Editor, "Motor Hints," care of this publication.

Third Prize $10.00

UNIQUE AUTO SWITCH LOCK

An inexpensive Auto switch lock may he had by forming a piece of rod-iron as shown in drawing herewith to fit snugly over the switch and light keys which are hollow-formed in the center, so that it cannot be taken off across the tops of the keys. The cycle lock shown (Yale) runs through the holes in the end of device and makes it a thief-proof lock as the switch keys cannot be turned.



Locking the Switches on a Car With a Yale Padlock.

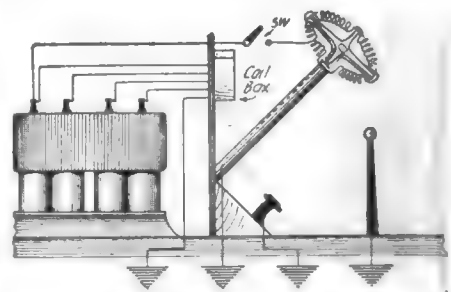
Note outline of device and padlock, and position of the keys, which are shaded and at A-A is an end view of both key and rod-iron device. Note the snug fit.

Slight modification will make it answer for other switch buttons.

Contributed by R. C. LEIBE

SHOCKING THE AUTO THIEF

Here is a good way to fool the auto crook. It works fine on Fords, because on them, one side of the secondary of the coil is grounded, and the other side runs to the spark plug. First get some No. 22 B. & S. bare copper wire and wind around the rim of the steering wheel, making sure not to let it touch the metal spokes of this wheel, because this would cause a ground and it would not work. After the wire has been wound closely, solder ends together and run a rubber covered wire down along the steering wheel shaft to a small single pole switch on the dash board, then from the switch to one of the spark plugs. When the thief gets in, starts the machine and everything is running nicely, nothing looks suspicious, until he grabs the wheel and tries to give it more gas to start off, but he feels something and jumps, and says to himself; "x—!—?—!— Nothing doing, this is too much for me to hold," and walks away before anybody has seen him. If you think placing the switch on the dash looks too suspicious, put it somewhere else, under the hood, for instance.



An Attachment to the Steering Wheel of a Car, Giving an Electric Shock to the Thief.

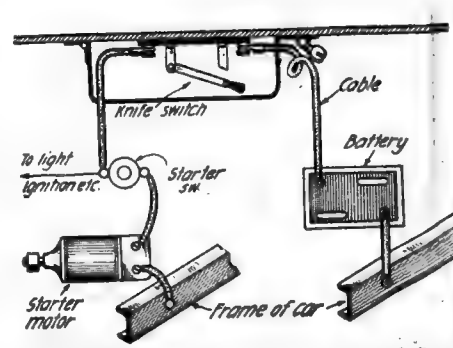
Contributed by FRANK A. VERGES.

THIEF PROOF IGNITION AND BATTERY PROTECTOR

Put a 110 volt, 100 amp. knife switch in series with your battery and starter switch. This will disconnect your electric system when knife switch is pulled out at night when car is not in use. Many fires have been started thru loose connections or defective wiring, but this will make it safe if switch is pulled open when car is not in use.

A good lock for car: This knife switch can be installed any place on your car where it will be handy to get at, and by placing a metal box on switch and locking it, the car cannot be started.

Contributed by
E. A. GREENQUIST.



A Knife-Switch Locked in Position by a Steel Cover to Protect the Battery and to Prevent the Car from Being Stolen.

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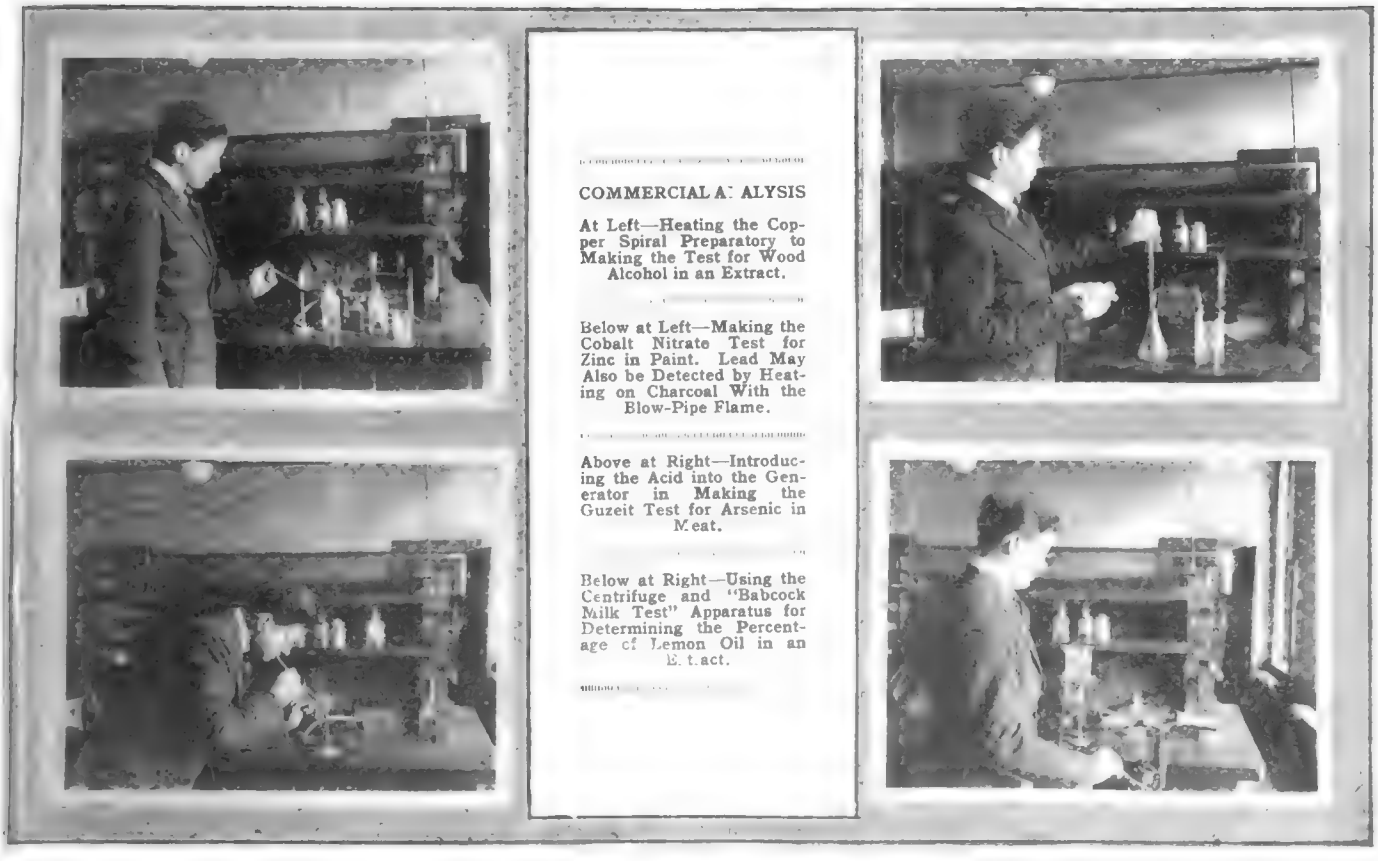
Practical Chemical Experiments

By PROF. FLOYD L. DARROW



COMMERCIAL ANALYSIS

At Left—Heating the Copper Spiral Preparatory to Making the Test for Wood Alcohol in an Extract.

Below at Left—Making the Cobalt Nitrate Test for Zinc in Paint. Lead May Also be Detected by Heating on Charcoal With the Blow-Pipe Flame.

Above at Right—Introducing the Acid into the Generator in Making the Guzeit Test for Arsenic in Meat.

Below at Right—Using the Centrifuge and "Babcock Milk Test" Apparatus for Determining the Percentage of Lemon Oil in an Extract.

IN my experience I have found no division of chemistry which appeals to the amateur chemist with a more compelling interest than that of commercial analysis. I assume, too, that the readers of this series of articles are identical in this respect with the members of my own classes. Such work gives skill in manipulation, develops a considerable knowledge of chemistry, and fosters an intelligent interest in the subject. It is absolutely foreign to that form of chemical procedure, which delights in putting into a test tube or beaker a little of every reagent to be found in the laboratory, just to see what will happen. Very frequently something does happen too, and sometimes entirely to the discomforture of the experimenter.

In this article I shall continue the methods of commercial analysis along lines similar to those followed in the previous article.

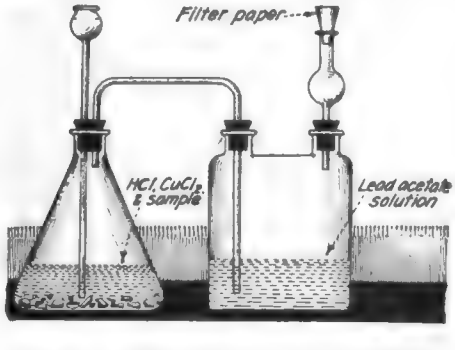
Testing for Arsenic

Arsenic very frequently contaminates such common articles of commerce, as foods, clothing, wall papers, paints, dyes, etc. Therefore, to be able to detect its presence is a matter of considerable importance. Such determinations, too, often figure in litigation and criminal procedure. But before any such determination can be accepted as reliable evidence, it must be perfectly certain that the chemicals used in the analysis are themselves free from arsenic. Therefore blank tests should first be made to test the purity of the reagents. These tests are made as follows:

Into each of four small flasks put a few pieces of zinc. Into flask No. 1 pour a little of a 10 per cent solution of hydrochloric acid. (Ten per cent HCl has 20 cc. of concentrated acid to 100 cc. of water.) Into flask No. 2 pour some 10 per cent sulfuric acid (6 cc. concentrated acid to 100 cc. of water). Into flask No. 3 pour a little of a mixture of 1 part of sulfuric acid to 30 parts of nitric acid. And in flask No. 4 pour some ten per cent hydrochloric acid containing a few drops of a ten per cent solution of cupric chloride (10 grams of the salt to 100 cc. of water).

Then immediately cover the mouth of each flask with a piece of filter paper moistened with a concentrated solution of mercuric chloride. There should be a brisk evolution of gas in each flask, and, if no arsenic is present in the reagents, there should be no discoloration of the filter paper at the end of half an hour.

The next step is to prepare the sample. In case of wall paper, fabrics and similar articles, cut into small pieces about 30 square centimeters of the sample and place them in an evaporating dish. Cover these with 5 cc. of the above mixture of arsenic-free nitric and sulfuric acids and add a few drops of water. Allow the action to proceed for six or seven minutes; then heat over a small flame until the acid fumes have been nearly all driven off. This process gets rid of the organic matter and oxidizes any arsenic compounds to arsenic acid. Now break up the mass left in the evaporating dish, cover it with water and boil for a few moments. Finally filter into a small beaker and wash the residue left on the filter paper with a small quantity of water, allowing the washings to run into the beaker. The resulting volume in the beaker should be about 50 cc.



Apparatus Set Up for Making Test for Arsenic in Commercial Products, Foods, Etc.

In case of meats, canned goods, etc., proceed as follows in the preparation of the sample: Place in a porcelain evaporating dish about 100 grams of the sample, cover it with 23 cc. of nitric acid, and heat, with occasional stirring with a glass rod. The contents of the dish will become a deep yellow color. When this occurs remove the burner, and add 3 cc. of sulfuric acid, and stir until the nitric oxide fumes cease to come. Then heat again gently, and when hot, add drop by drop, 8 cc. of nitric acid with constant stirring. Continue the heating until the fumes of sulfuric acid are driven off. Then break up the residue left in the evaporating dish, extract it with boiling water, filter, and wash as before.

The Gutzeit Test: Arrange apparatus as shown in the accompanying cut and in Fig. 1. In the Erlenmeyer flask used as generator place some arsenic-free zinc and in the double necked Wolff bottle a solution of lead acetate. The double angled delivery tube must dip beneath the surface of the lead acetate solution. In the second neck of the Wolff bottle place a stopper carrying an empty calcium chloride tube, into the upper end of which, is thrust a piece of filter paper, wet with a few drops of a saturated solution of mercuric chloride.

Now cover the zinc in the generator with some of the previously tested hydrochloric acid which contains a few drops of a ten

(Continued on page 359)

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Freak Phonographs

Including the "Shingle" Resonator and Electric Tone-arms for Loud-Talkers

By H. JOHNSTONE

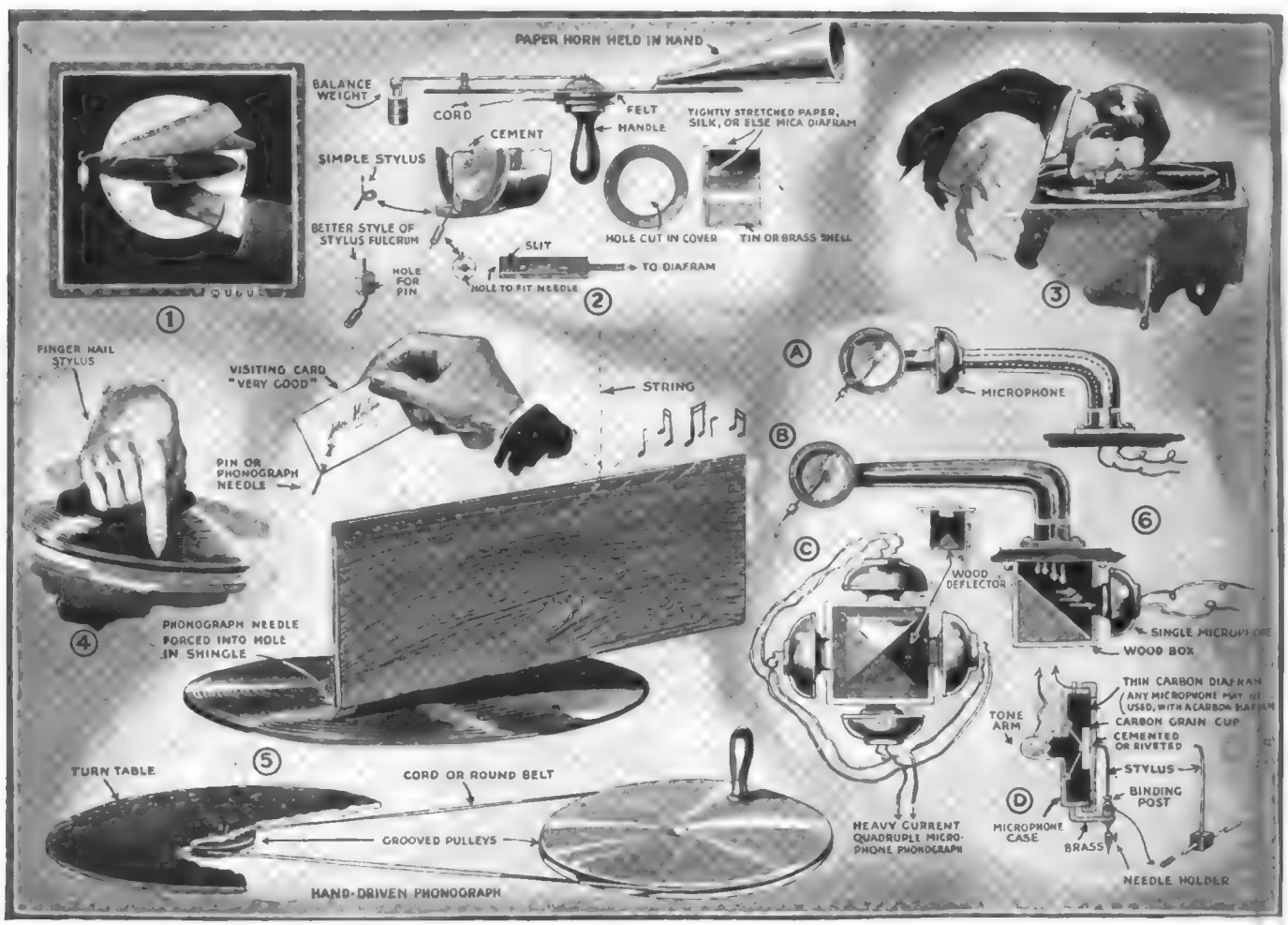
THEY haven't got to the point just yet where you can buy a talking machine in the five and ten cent stores, but in view of the fact that they have succeeded in producing a wonderful little electric motor to sell for a dime, we presume we may expect a phonograph for the same sum, eventually. The cheapest phonograph we have seen so far sells for $1.00, and appears in Fig. 1 of the accompanying illustration. Several details of the $1.00 phonograph are shown in Fig. 2, as well as several improvements suggested by the editors. In general this simple phonograph, which is more of a toy than anything else, works as follows. You place the record on the felt covered pulley; having previously wound up the string on this pulley, and at the desired moment the string is given a sharp pull, causing the pulley and the record to spin rapidly, the same as a boy's top. The paper horn with the needle is held on the record by hand. Of course the reproduction is not as even or as effective as that from the large parlor machines, as there is no means of keeping the speed constant, as becomes evident.

A novel experiment in the science of phonography involves the holding of a phonograph needle between the teeth and then bending over the rotating turn-table and record inserting the end of the needle in the groove of the record, when the volume of the sound heard thru the needle and the teeth will prove quite astonishing. Mr. H. Gernsback was one of the first who experimented in trying out this stunt, which was described in some detail with several variations of the effect, in a previous number of this journal, as many of our readers will undoubtedly remember.

Even a sharpened finger nail, if held in the groove of the revolving record, will give a fair reproduction of music and the writer's little cousin, aged 7, recently derived a lot of fun and amusement from the family phonograph, when he found that he could reproduce music, for himself, for no one else could hear it, from the revolving record, by simply holding the phonograph needle or a pin between his fingers.

The experiment shown in Fig. 5 has been tried by the writer with excellent results, and here the ubiquitous shingle instead of being used to "educate" children, is made to give forth music in a more pleasing and harmonious manner, simply by punching a hole in the end of the shingle, as shown, into which a phonograph needle is inserted. A loud or extra loud steel needle should be used. With a little ingenuity the "freak phonograph" can be rigged up with the shingle so that it will swing easily and be carried across the record as the turn table

(*Continued on Page* 378)



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Speaking of Freak Phonographs, We Illustrate Above a Few Choice Specimens, Which Will Undoubtedly Prove of Interest to Experimenters in Acoustics. Fig. 1 in the Upper Left-Hand Corner Shows a $1.00 Pocket Phonograph, While the Details of Such a Machine Are Shown at Fig. 2. Fig. 3 Shows How Phonograph Music May Be Heard by Holding a Steel Phonograph Needle Between the Teeth, While Fig. 4 Indicates How the Sound May Be Interpreted From the Record by Virtue of a Pointed Finger Nail. A Phonograph or Other Needle Mounted on the End of a Stiff Visiting Card, Held in the Hand, Proves Quite a Surprise, While the Wooden Shingle, Shown at Fig. 5, Has Been Tried by the Editors With Excellent Success. A Hand Drive for a Simple Phonograph is Shown in Fig. 5, While Fig. 6 Shows Several Types of Electric Tone-Arms for Use With Radio Telephone Sets, and Also for Modulating the Current Supplied to Telephonic Loud-Talkers Such as the Magnavox and Others.

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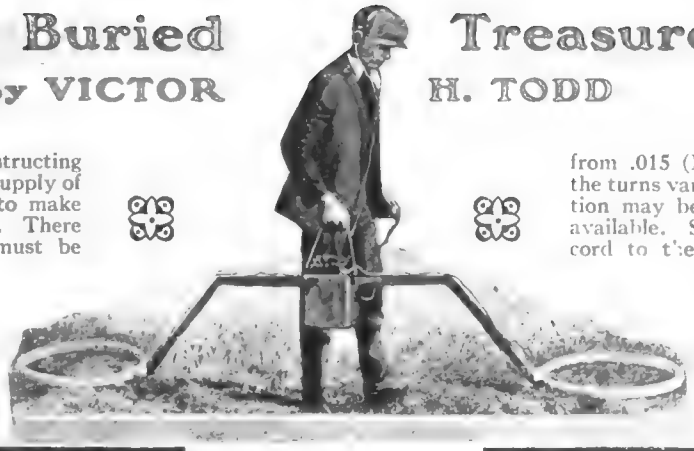
Building A Buried Treasure Finder

By VICTOR H. TODD



THE first requisites in constructing this apparatus are a good supply of patience and the ability to make good soldered connections. There are two circuits which must be absolutely identical under normal conditions and any difference such as is caused by one circuit coming under the influence of buried metal is detected by a differential current transformer. Consequently there must be no loose joints in either circuit. They must be perfect. There must not be one or two turns or feet of wire in one circuit more or less than the other. They must be identical.

With these points in mind and the ability to do a workmanlike job we can commence construction. For the two large exploring coils, we must build a mould made by nailing ¾ inch boards in two layers, with the grain at right angles, so that they form a block 2 ft. x 2 ft. x 1½ inch thick. Out of this, cut a 2 foot diam. circle or leave the mould square as desired. Now mail more thin boards on one side to project ½ inch all around the edge and the same on the other side, except that this side is attached with screws. Fig. 1 shows the mould and the method of winding.

The coils may be wound with any size of copper wire from .064 (No. 14) to .101 (No. 10) with any insulation such as enameled, single or double cotton, and the turns from 60 to 100, winding in even layers according to the size of wire used. But *both coils must be identical* in turns, size of wire and insulation. After winding the desired turns, the one side of the mould may be unscrewed and the coil slipt off, fastening it in several places to keep in shape, by wrapping it with black friction tape. Now tape the whole coil thoroly, using ½" or ¾" taffeta or linen tape overlapping one-half. When both coils are wound and taped, give a good coat of orange or white shellac, and dry thoroly. Cut the heavy wire about 2 inches from the coils and solder to each, a 6 foot length of heavy lamp cord. Tape the joints after close inspection to see that they are perfectly soldered.

The instrument panel may be drilled as shown in Fig. 2 using preferably ¼" black micarta; hard rubber, fiber or hard wood will answer as substitutes if necessary. The mounting of the terminals, switches, ammeter and buzzer is shown in Fig. 3. To construct the rheostat, drive copper or brass nails or wire into the little holes and then laying a turn of No. 16 German Silver or *Advance* wire over their heads, carefully solder the wire in place at each junction. Solder the ends to the two heavy screws provided for that purpose.

The contact making buzzer is easily made from an ordinary buzzer. First solder the vibrating spring solid to the iron armature, at the same time catching a little brass strip which carries the extended contact. This spring must be solid, to give a very high frequency, as well as to make the buzzer almost noiseless. An ordinary binding post may be threaded to take a screw for the stationary contact and mounted as shown. The contacts must be made of some non-arcing metal such as silver, and if possible, should be of platinum or iridium. Ordinary brass, copper or iron at the point of contact will not operate perfectly.

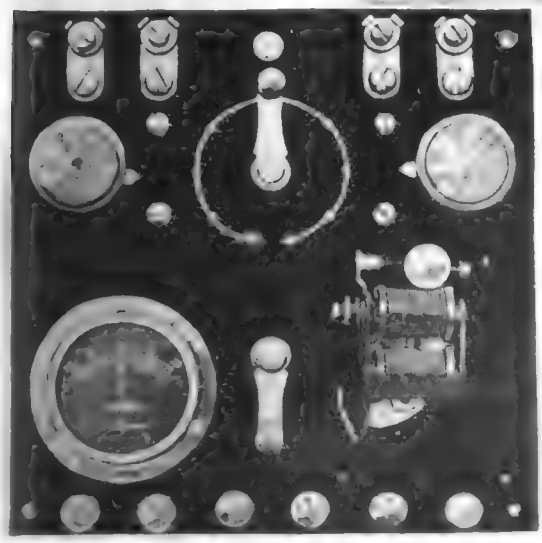
The next point demanding the utmost care and patience in its construction is the differential current transformer. A micarta tube, about 2" long and ½" x 5/8" diameter, should be fastened to two end supports, either moulded composition or micarta or a wooden block to form a mould. The ends must not be made of metal. Place it on a ½" mandrel in a lathe or winding fixture. First solder a 12" length of thin lamp cord to .010 (No. 30) copper wire, insulate the joint thoroly, bring out the end, anchor it temporarily and then wind a full even layer, ending about ⅛" from the side of the mould. Cover with a full turn of rice or glassine paper and wind a second layer, keeping the lathe always running in the same direction. Wrap another layer of paper, and then another layer of wire, keeping the layers of wire about ⅛" from the ends of the mould and adding layers of wire and paper until the coil is about 2" diameter. It should now contain about 6,000 turns, but this may vary within wide limits without materially affecting its sensitivity. The size of wire may vary from .015 (No. 26) to .005 (No. 36) with the turns varied accordingly, and the insulation may be enameled, silk or cotton, as available. Solder a 12" length of fine lamp cord to the end and anchor securely at several places. Wrap a layer of book-binder's cloth around the coil to give it a finished appearance.

Now on a temporary mandrel, wind two heavy wires, about .064 (No. 14), in parallel so that they will slide snugly into the secondary tube. Be sure to get *exactly* the same number of turns in each circuit. To facilitate this, it is well to wind a temporary coil and then unwind to get the correct length. Cut off two new wires to the same length and rewind. When the primary, with its two wires wound in parallel, is in place, shellac inside with a small brush. Then make a tube of thin fuller board and slip this inside the winding. The space inside this must now be filled with soft annealed iron wire, cut into lengths about 2¼" long. Force in as many as possible and run shellac into the ends to prevent any shifting, when complete.

The transformer may now be fastened to the face plate and the heavy leads scrapt and anchored. Before further connection, the transformer must be adjusted by connecting as in Fig. 1 and moving the heavy primary wires slightly up or down, near to or away from the core, until absolutely no sound is heard in the receivers. This adjustment is important and must be done carefully and not be disturbed after it is once made. Even an ⅛" movement of a primary wire may disturb the adjustment.

The inductor balances are easily made by winding 10 turns of .064 (No. 14) insulated wire on a temporary mould and anchoring to the micarta support as shown in Fig. 5. They hold their shape from the rigidity of the wire. They are assembled in place at the ends of the transformer, so that their field may oppose, assist, or be at right angles to the axis of the transformer core. The set may now be wired as in Fig. 6, taking care to get good joints. Fig. 7 shows the completed panel rear view.

A hard wood case may be used as in Fig. 8 to contain the batteries and plate and also to form a support for the coils. A wooden block, taped well to the coils, gives a good support for the handles. The coils



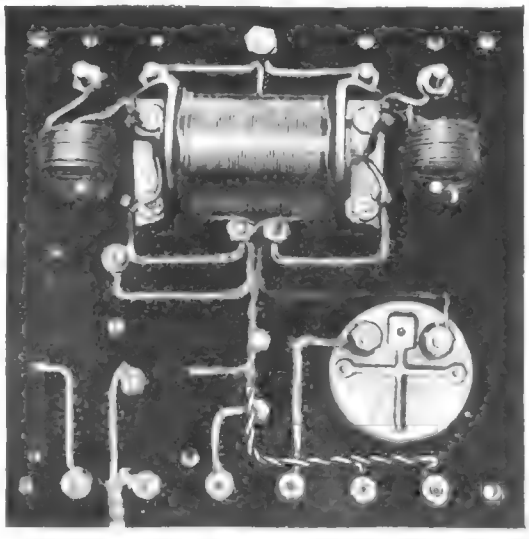


Photo Above, Fig. 8, Shows Operator Using the Buried Metal Locator Here Described in Detail by Mr. Todd, Who Has Built Several of These Machines With Great Success. It Operates on an Ordinary Battery Comprising a Few Dry Cells, and Is Very Useful and Valuable in Locating Any Buried Metal Deposits, or Pipes, and When Properly Adjusted, It Should Indicate Such Underground Metal Whether Iron or Not, as Deep as 25 Feet and Possibly More, if the Instrument is Very Carefully Made.

The Photograph at the Left, Fig. 3, Shows a Top View of the Switch Panel Inside the Cabinet, the Buzzer-Interrupter, Ammeter and Control Switches Being Clearly Shown. The Rear View of the Switch Control Panel is Shown at the Right, Fig. 7.

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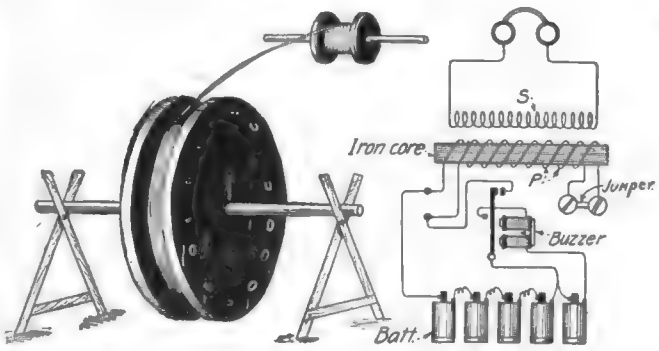

Fig. 1

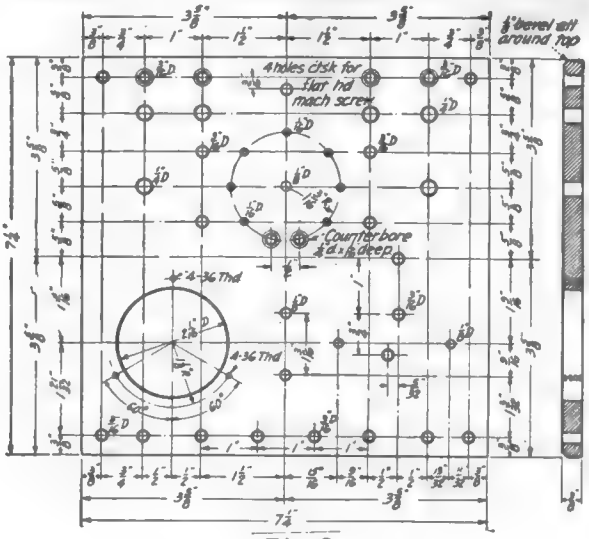

Fig. 4

Fig. 2

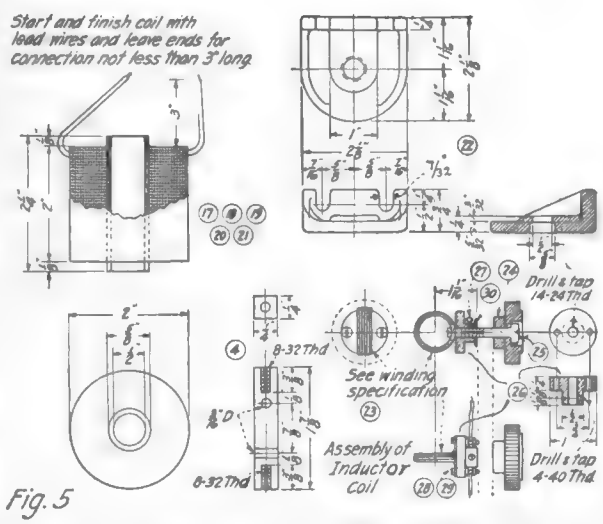
Start and finish coil with lead wires and leave ends for connection not less than 3" long
Drill & tap 14-24 Thd
8-32 Thd
See winding specification
Assembly of Inductor Coil
Drill & tap 4-40 Thd
8-32 Thd

Fig. 5

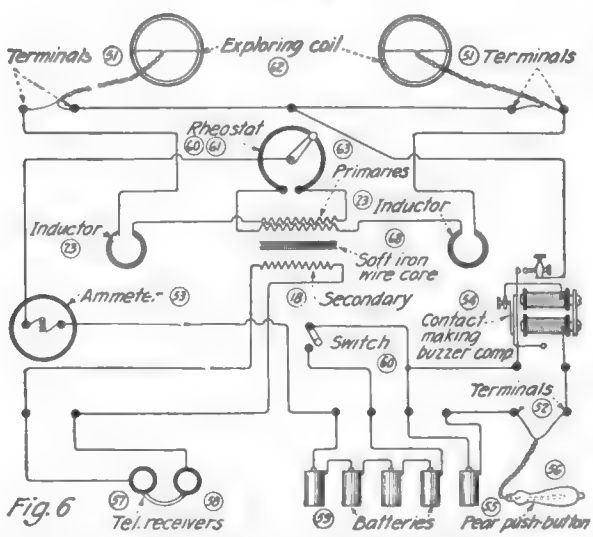

Fig. 6

The Above Drawing Shows Details to be Followed in Building the Metallic Ore and Pipe Locator Here Described by Mr. Todd. The Switch Panel May be Made of Hard Rubber, Black Fiber, or Bakelite. All of the Wire Leads Should be Carefully Arranged, and Made of Equal Length as Nearly as Possible, in Order to Help in Balancing the Circuits When the Instrument is Assembled and Ready to be Calibrated. The Indication that the Exploring Coils are Over Buried Metal Pipes or Other Mass Is Given by Sound in the Telephone Receivers Worn on the Head. The Presence of Any Metallic Mass Buried in the Ground, Anywhere from Five to Twenty-Five Feet Deep, Causes the Inductive Balance Between the Two Exploring Coils to be Upset and it is this Differential Effect that is Indicated or Measured by the Telephone Receivers. It Would Also be Possible to Make the Instrument Direct-Reading by Using a Very Sensitive Galvanometer, Connected in Place of the Phones, and Suitably Calibrated.

must be kept the same distance apart or there will be *interference*.

Now select an open out-door field, free from buried water pipes or metal junk and setting the instrument on a temporary stand, close the main switch. Push the pear push-button to start the buzzer and slowly screw in the stationary contact until it just makes contact. The correct point is easily determined by a slight increase in the pitch of its tone and the indication of about 1 or 2 amperes on the meter. If too close, it will indicate 10 or 12 amperes and quickly exhaust the battery.

Next place an ordinary magnetic compass in the center of each coil in turn and note which end dips down. If it is the blue or North end, then connections are correct. If white or South end, the connections to that coil must be reversed at the instrument board.

Put the receivers on and push the button. The buzzer should be loudly heard. Move the rheostat handle until the sound is at its very minimum. Then turn the inductors slowly until the sound is *absolutely balanced out*. It may be necessary to slightly change the rheostat position, after an adjustment of inductors, but the adjustment must be obtained so close that no difference in sound can be detected with the main switch open or closed.

With the apparatus as in Fig. 8, start at one corner of the plot to be explored, and setting the coils lightly on the ground push the button. If no sound is heard, advance the coils about two feet, set them down and again push. Repeat this until the whole plot has been explored. By thus dividing the plot up into two foot squares, it can be covered much more quickly and thoroly than if the instrument is carried in a haphazard manner several inches from the ground.

If a sound is heard, then the coils may be shifted until the greatest sound is heard when it will be known that one coil is directly over some buried metal. It is important to note that the coils and instrument must bear a fixt relation to each other and also that the operator's head, with the receiver's, must stay in the center between the two coils. If the head is bent a foot or so forward, the field from the exploring coils may cause a sound.

It must also be remembered that the change in the two circuits caused by any buried metal is so exceedingly small, that it may easily be caused by other slight changes and it is only by eliminating every other variable that correct operation can be secured.

Wood for Storage Battery Purposes

Some practical notes on the use of wood in secondary batteries and for the cases for sets of cells have been publisht in the *London Electrical Review*. It limits the list of woods in use in England for these purposes to pitchpine and teak. The author, Sir John Anderson, puts the transverse strength of a bar of teak one foot long, by one inch square as 814 pounds, while the same size bar of pitch pine, only runs to about 550 pounds. The critical use of wood is for separators in the cells; the wood used for this purpose having to be chemically treated to get rid of the wood acids and it is necessary for it to be extremely porous, as it really represents a porous diafram. After chemical treatment, the separators are kept in water, for they must never be allowed to dry, as they would warp and split.

Standard use now favors the employment of thin sheets of wood, where formerly wooden dowels were used. In the case of grid-type negative plates, the separators may be placed against such negative plate, but must never be allowed to rest against the positive plate, as this interferes with the free diffusion of the electrolyte and causes sulfating. Wood used for containers or cases for the battery should be treated with paraffin wax melted into the pores of the wood. The wood separators, it must be remembered, have very little strength and must be handled with great care if they have to be removed from the cell. They are certainly the weak spot in the structure, and it is highly desirable that some practical substitute for them should be found.

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Small House Refrigerating Machine

By JOHN GORRELL

INTRODUCTION

BEFORE anyone can talk intelligently on the subject of refrigeration he must understand the principle on which the system works. In order that the reader may have an understanding suitable for the discussion and building of the machine, he should carefully examine the diagram below.

We shall assume that the valves F, B, and C are closed and D and A are wide open while the expansion valve is just barely opened. Furthermore that the condenser contains about ten to fifteen pounds of Sulfur dioxide (SO_2) in a liquid state under forty pounds pressure to the square inch. The pressure forces the liquid thru the small opening in the needle valve (also termed the expansion valve) into the cooling coils which are in the ice chamber. When the liquid is in the cooling coils, due to the lower pressure, it (the liquid) turns to a cold gas, which in turn robs the surrounding foodstuffs and air of their heat. When the gas has absorbed enough heat, it is comprest in the condenser under a pressure and is allowed to lose the heat obtained in the ice box and that gained thru compression. When the hot gas has cooled sufficiently it returns to its former liquid state, only to go thru the same cycle an indefinite number of times with little or no loss.

CONDENSERS

There are two types of condensers used, namely the air and water cooled types. The former is less expensive to use and construct but is not as efficient as the latter type, which uses from one to ten gallons of water per hour.

Under each type there are several models. The type as it is shown in the cut is made of one-quarter or three-eighths inch copper tubing. The minimum length is fifty feet while the greater the length (up to one hundred feet) the less time will be required for the gas to cool, as the surface area is larger. Seventy-five feet are enough for the average ice box.

A tank of any kind is made in which the coil is entirely submerged in water which is continually changing. This is brought about by having a pipe from the water mains, lead through a valve, to the bottom of the tank. With a drain pipe at the top, the water should not remain in the tank, when warmer than eighty degrees F. The amount of water needed will depend on how often the box is opened, the temperature of the room, and the weather.

If so desired, the coil need not necessarily be in the water, as it will operate if exposed to the air, tho not so well. If this is done, it would be well to place a fan on the motor or idler shaft. The air currents thus set up will greatly aid the cooling of the condenser coils.

An ideal and cheap condenser may be readily afforded by the use of a small hot-water or steam radiator, such as is used in heating systems. This radiator may be as large as convenient, altho one of six to eight sections (or coils) eighteen to twenty-four inches high and from six to twelve inches wide, will be large enough for most cases.

Any type of condenser must be placed, so that the liquid will all drain to the inlet pipe. If the radiator is used it is well to place it on an angle of twenty to thirty degrees. Any type of condenser and compressor may be placed above or below or to one side of the cooling coils, as pressure will force the liquid to the needle valve.

EXPANSION VALVE

The expansion valve, which marks the starting place at which refrigeration takes place, is a needle valve placed just outside the ice chamber or better, within it. Do not at any time tighten this valve more than necessary, as the seat is easily ruined.

COOLING COILS

There are two distinct types of refrigeration (cooling) coils, first there are the ones submerged in brine and those that are not. If the coil is to be placed in brine (concentrated solution) care must be taken to see that the tank is made of a material (metal) not affected by brine. An old copper wash boiler, reconstructed, is very satisfactory. This type is better because the temperature is more even.

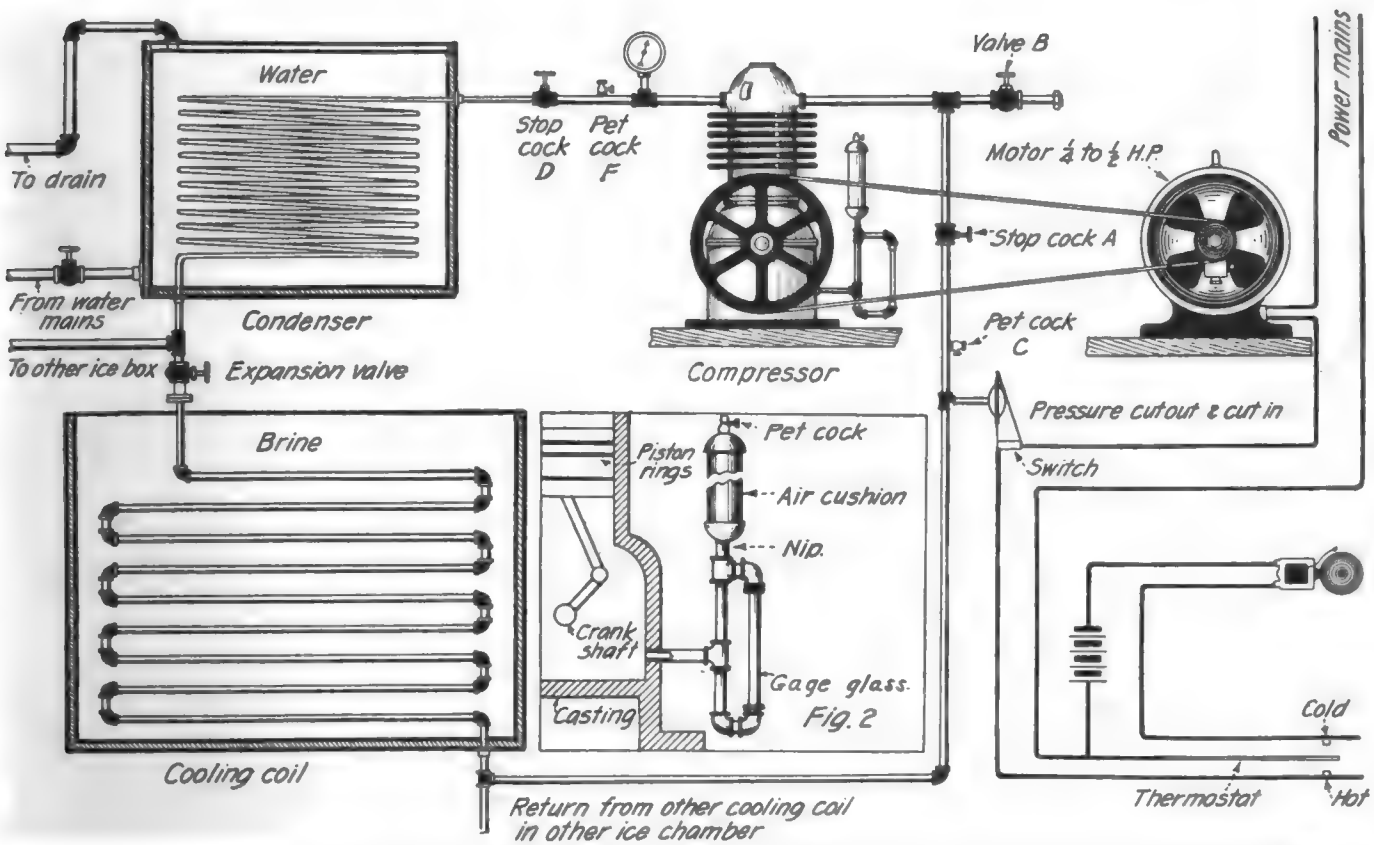
COMPRESSOR

This is the most expensive item in work and money as it is impossible (so far as I have been able to learn) to purchase an absolutely gas-tight machine of the small size. The next best thing to do is to purchase a compressor nearest to our needs.

When the machine comes from the factory it may require considerable machine work.

It will be seen by examination that the gas has several avenues of escape. This is not as bad as it may sound, since but one requires any great amount of work. Some six avenues will be enumerated with the methods of stopping them: No. 1. The air compressor has a hand release valve

(*Continued on page 375*)



How Often Have You Wished That You Could Discharge the Iceman and Make Your Own Ice With a Little Machine Stored Away in the Corner of the Kitchen or Cellar? In the Present Article Mr. Gorrell Tells Us How He Built His Own Machine For Manufacturing Ice. All the Parts Used Are Standard Ones and Can Be Purchased on the Open Market, Including the Sulfur Dioxide, Which Is the Refrigerant Employed in This Machine

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Measuring Thousandths of a Second

By F. L. BARROW

IF you were asked the question, "How is time measured?" your immediate reply would probably be, "By means of a watch, clock or other similar recording device," and if asked to say how you would time, for instance, a sprint of 100 yards, you would suggest a stop-watch, starting the watch on the sound of the pistol, and stopping it with your finger as the winner breasts the tape. His time would then be taken by reading the watch, usually to one-fifth of a second.

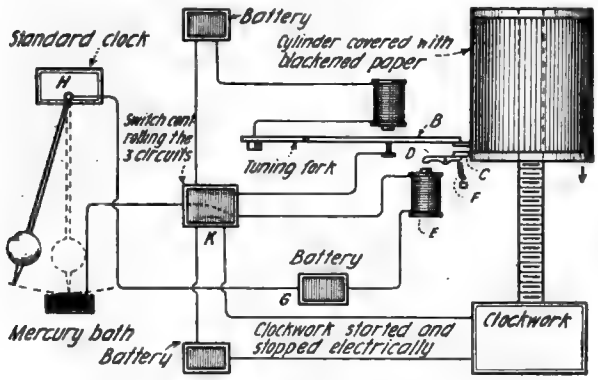


Fig. 1

But suppose you had to measure the time taken for a strong spring to snap back into place when released, or a heavy weight to fall one foot, or to time *one vibration* of a tuning fork, your stop-watch would then be a very inefficient and probably useless instrument.

As an example of more accurate methods for measuring minute periods of time, let us consider the vibration of the tuning fork. Suppose our fork is said to vibrate 256 times per second—quite a normal value—and we wish to verify this experimentally. The diagram shows how this is done.

A large drum is rotated by clockwork mechanism in such a way that it moves spirally on a screw thread and thus rotates and falls at the same time. The clockwork is wound up and a brake put on. The outer surface of the drum is covered by a piece of stiff white paper coated with lamp black.

"B" is our tuning fork carrying a small metal pointer soldered on the end of one arm. The end of this pointer rests just against the blackened surface of the drum at its lower end.

"C" is another pointer just below "B" and also in contact with the drum, and is fastened to a trigger D, whose other end is capable of being attracted by an electro-magnet "E," and drawn away again by a spring "F." The magnet in its turn is excited by a current from battery "G." There is, however' a break in the circuit at "H," where one wire is attached to the top of the pendulum of a reliable standard clock, while the other dips into a mercury bath directly below.

By Means of the Apparatus Shown at the Left and Which Is Much Simpler than It Might Appear at First Glance, It Bebomes Possible to Measure Even Such Small Fractions of Time as the Thousandth Part of a Second

The Actual Chart Reproduced at the Right Shows How the Tuning Fork Records Its Vibration Time Period on the Revolving Drum

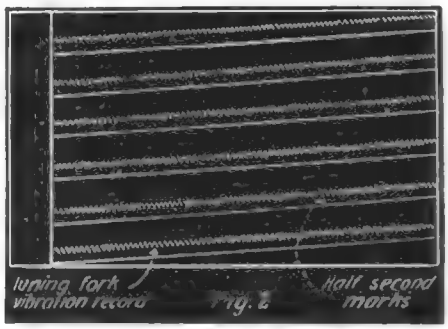
Now, when the pendulum swings thru its lowest position, its lowest joint just dips into the mercury bath and completes the otherwise broken circuit. This completion of the circuit is thus made to occur at half-second intervals, which are very accurate if the clock is reliable. Thus we have the electro-magnet operating every half-second and your pointer "C" gives an upward movement along the surface of the drum every half-second.

There is another electro-magnet and battery apparatus arranged to set the tuning fork vibrating. In this case, the spring drawing the fork away from the magnet is the elasticity of the fork itself, and thus it will move to and fro with its natural vibration, just as if "bowed" like a violin string or struck on a table.

The fork is electrically controlled in order that its motion and the vibratory motion of "C" may be started simultaneously from the same switch, K. This same switch may also be used to control the brake of the clockwork turning the drum.

Now let us see what happens when we close the switch and connect up the three circuits.

In the first place, the drum rotates at a speed of say one or two revolutions per second—and descends vertically at the same time. Also the pointer "C" gives one vibration every half-second, so that in addition to the white line showing where the lamp black has been swept off by the pointer traveling along, we also get small vertical lines representing half-second intervals.



The other pointer "B" vibrates up and down with the tuning fork and must obviously trace out a wavy line on the surface of the drum.

When the whole surface of the drum has been covered, the action is stopt and the paper taken off and placed out flat. Its appearance is something like what is shown in Fig. 2, *white* lines on a *black* background.

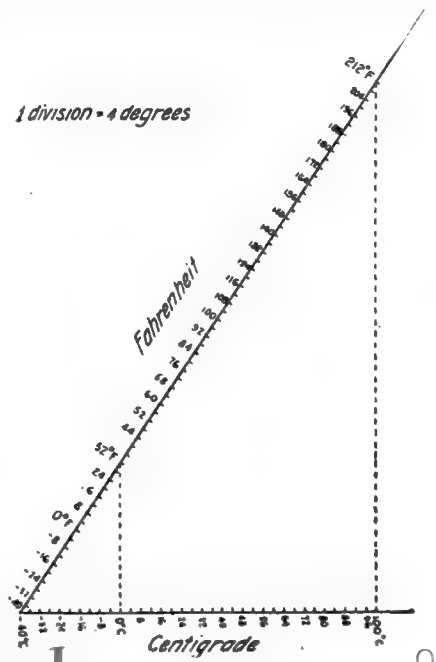
All that remains is to count the number of complete "ups and downs" of the wavy line, or the number of *wave crests* between any two half-second kicks, and multiply by two to give the number of vibrations per second of your tuning fork.

There may, of course, be many variations of this method to suit different requirements and conditions, but this example will illustrate the principle upon which extreme accuracy of time measurement may be obtained.

Conversion of Centigrade and Fahrenheit

This graph can be used in quickly changing a reading from one temperature scale to another. To begin with, we know that—40 degrees is the same on each scale. We construct our triangle with the juncture of the hypotenuse and lower side representing that temperature. We have the ratio between the hypotenuse and the base 9:5, which is readily understood. Then the base and the hypotenuse are marked into divisions of any desired size. The ones used in the figure represented four degrees each. Starting from the point that represents —40° we mark off ten divisions and that brings us to zero on either scale. Other readings can then be marked on the two sides, those on the hypotenuse represent Fahrenheit and those on the base, Centigrade.

By Means of the Accompanying Chart Temperature Readings in Either Fahrenheit or Centigrade May Be Quickly Converted from One to Another. Those Who Have Much Use for a Chart of This Kind Will Find It Advisable to Reconstruct a Much Larger Graph, Say About Four to Six Times the Size of This Cut. This Can be Done Quite Easily by Following the Angles and Divisions Given on the Chart Herewith



If one wishes to change from a Fahrenheit reading to one on the Centigrade he takes a straight edge and places it parallel with the third side of the triangle so that the edge runs thru the temperature to be changed. A glance at the point where the edge intersects the base will give the Centigrade reading.

The formula that can be used with this method is:

$$°F = (°C + 40)\ 9/5 - 40$$
$$°C = (°F + 40)\ 5/9 - 40$$

This may be more easily remembered than the method ordinarily used. We take the temperature reading and add forty because that represents the number of divisions below the zero point. Having the total number of divisions, then, we multiply to change over into divisions equivalent on the other scale. To change those divisions into temperature reading we must subtract forty because forty of the number are below zero.

Contributed by
WILLIAM E. GILLIS.

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Simple Substitute for the Photostat

REFERRING to the article on "Full size copies without a copying camera," page 1095 of your February number in "How to Make It" department I would point out that there is a very much simpler method.

Take a sheet of "gaslight" paper and place it face down over the picture or other matter to be copied and cover with a glass (as heavy as possible) and expose to light. *The light should fall on the back* of the gaslight paper, and not on or thru the picture to be copied. Develop and use as a negative. Hard or contrasty grades of paper must be used.

I enclose several specimens of negatives and prints, which naturally show the grain of the paper. The paper of course can be made translucent if desired by the use of waxes, oils, or varnishes and plates or films can be used.

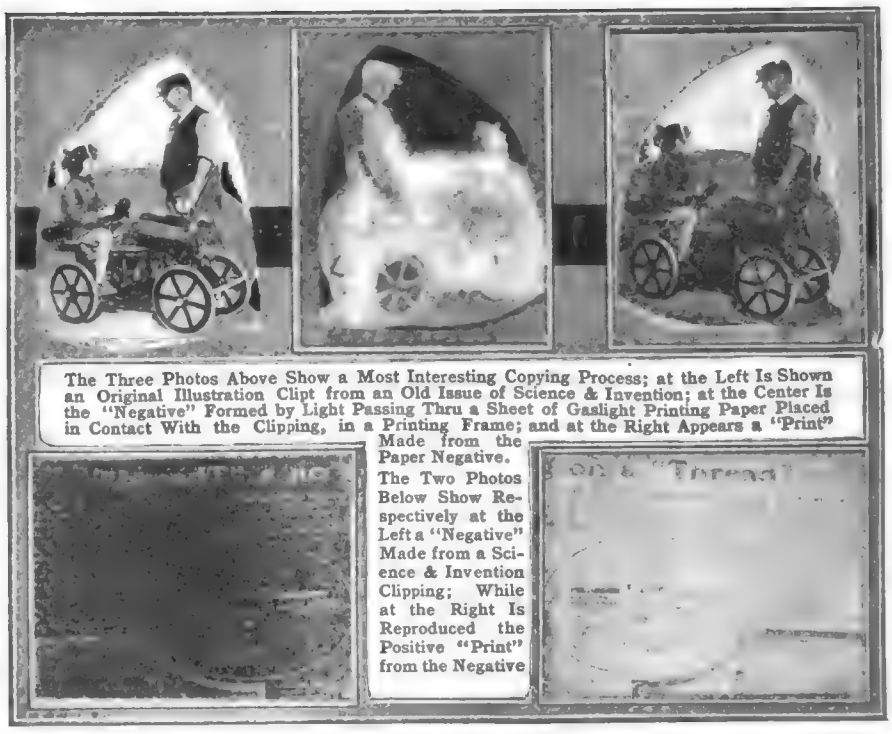
I enclose one print taken with a process plate which shows foggy smudges due to the uneven illumination given by a match. Properly I should have used a ground glass and a more even source of illumination. The gaslight paper process is very handy for copying drawings or print in libraries.

The explanation of the phenomenon is simple as the blackened parts of the matter to be copied reflect less light and so the sensitive emulsion over the white parts is more quickly acted on. One friend suggested that the black has a further reversing or protective action, but this is not necessary to explain the phenomenon.

Printing out papers or blue print paper will not work, probably owing to the color produced at the back by exposure preventing further rays passing.

An improvement would be to use a "bleaching out" paper (such as was sold under the name "Uto" for example some years ago for color photography), as this would allow the paper over the white parts to become pure white and that over the dark parts to remain dark. This would produce a positive at the first operation and also eliminate the small amount of fog that exists in the present process, at least unless special methods such as reduction and intensification are employed.

In addition to the use in libraries (which I commend to the attention of all public librarians for the use of the public) there are many other possible applications such as copying checks, wills, and contracts and taking full size copies of signatures and finger prints. The method if commercially improved ought to do away with the expensive and bulky photostats now used for these purposes, besides being more handy and flexible.



The Three Photos Above Show a Most Interesting Copying Process; at the Left Is Shown an Original Illustration Clipt from an Old Issue of Science & Invention; at the Center Is the "Negative" Formed by Light Passing Thru a Sheet of Gaslight Printing Paper Placed in Contact With the Clipping, in a Printing Frame; and at the Right Appears a "Print" Made from the Paper Negative. The Two Photos Below Show Respectively at the Left a "Negative" Made from a Science & Invention Clipping; While at the Right Is Reproduced the Positive "Print" from the Negative

A special film (or better plate) with gaslight emulsion or with bleach out emulsion ought to be put on the market for this purpose and so prevent the slight difficulty with the grain of the paper and yet allow us to dispense with the dark room.

I may mention that the process other than the bleaching out variety is not my idea but was known in Ireland at least 10 years ago as "Anastatic Photography" but has evidently not been widely publisht.

By D. P. W. MAUNSELL.

Funnygraphs—and How They Got That Way

Almost every amateur photographer has a few old film negatives which he will not use again in the usual way, but which can be used for making these "funnygraphs."

The directions for making these follows:

1. Take the old discarded negatives, and with a sharp safety razor blade cut out the head and shoulders, being careful not to cut away any of the features.

2. The body is then drawn on thin paper, the thinner the better. They can be drawn free hand or copied from some comic sheet. It is best to use black drawing ink for the outline.

A Clever and Interesting Photographic Stunt Is Shown in the Accompanying Two Photos. The Comic Figure Is Drawn on Thin Paper and Then Cut Out and Used in Connection With a Trimmed Film Negative of the Face

3. When the outline is finished, cut out around the figure. If coat or trousers are to show black when printed, cut out on inside of outline also.

4. Then take the head and figure and place them face down on the glass of a printing frame, placing the printing paper over them. Print in the usual way.

Pictures made in this way are a novelty for the snapshot book and your friends will wonder "how they got that way."

Contributed by H. E. CARTER.

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Construction of a Good Chemical Balance

By E. H. SWANSON

THE average experimenter's laboratory is conspicuous by the lack of a Balance for accurately weighing small quantities of chemicals. The reason for the absence of this highly important piece of apparatus is usually to be found in the high prices charged by manufacturers for even a low-grade instrument. Yet the construction of a very good Balance is within the ability of any experimenter and the material can be found in the junk box of the average laboratory.

Fig. 1 illustrates the general appearance of the Balance which will be described herewith.

The instrument consists of a base ¾"x 4"x9¾" and an upright ¾"x1½"x7½". The base and the upright are beveled stained and finished, and the upright screwed to the base as in Fig. 2.

Now procure (this is an odious word to most experimenters), the hair-spring wheel of an alarm clock or any defunct time-keeping mechanism, watches excepted; also the frame in which the wheel is secured.

Remove the balance-wheel and axle from the frame. It will be observed that the wheel operates on pivot bearings and will fall out easily if the screw sockets are loosened. Remove also the hair spring from the wheel. The frame will now appear something like Fig. 3. Cut this frame as shown and smooth the brass with a file. Mount the frame by means of screws, on the upright, so that the two small socket or bearing-screws will clear the top of the upright as in Fig. 2.

The next step: Take a ⅛" brass rod (round) 7¾" long and threaded at both ends for a short distance. At the exact center of the rod solder it to the hub of the hair-spring wheel, previously mentioned, in such a manner that the rod rests upon the axle of the wheel and tightly against the wheel itself.

Now flatten one end of a piece of No. 24 steel or brass wire, by pounding it upon an anvil; bend it into the shape shown in Fig. 4 and solder one end to the spoke of the wheel as illustrated. File the other end to a point.

Insert the wheel into the frame and tighten up the screw sockets.

After this secure two pieces of No. 24 gage aluminum sheet, 2½" square. These form the pans of the balance.

From No. 14 aluminum wire construct the hangers as in Figs. 1 and 5. Fig. 5 illustrates the bending of the ends to support the pans, of course holes must first be drilled in the pans and the wire pushed thru before the ends are bent into shape. Fasten the completed hangers to the brass rod as shown in Fig. 5. The distance of each hanger from the end of the rod is ⅝ inch.

Before finally fastening the hangers in position slip on the rod a couple of riders as they are called, each having a tightening screw. These riders may be obtained from your "kid" brothers "Erector" set, or purchased at a hardware or electrical shop for 5c. apiece (binding posts). Then on each end of the rod screw into place a nut.

In preparing the hangers and pans it is necessary that care be taken to have the parts of exactly the same dimensions, otherwise the sensitivity of the balance will be impaired. A little extra effort put forth in careful construction at this point will repay the additional time spent.

When the rod, or beam of the balance is in place as in Fig. 1, the pans should clear the base by about ⅝" and the pointer should be straightened until it is at right angles to the beam as here illustrated.

Make a paper scale in divisions of 1/16" and mark the center graduation o (zero). Fasten the scale to the upright near the base so that the pointer will swing over it. Fig. 1.

See that the wheel turns freely in the bearings—a bit of fine watch oil will help. Then move the riders until the pointer comes to rest over the zero point on the scale. Tighten the screws on the riders and make the final adjustment by means of the nuts on the ends of the rod, screwing these a few turns in or out as may be required.

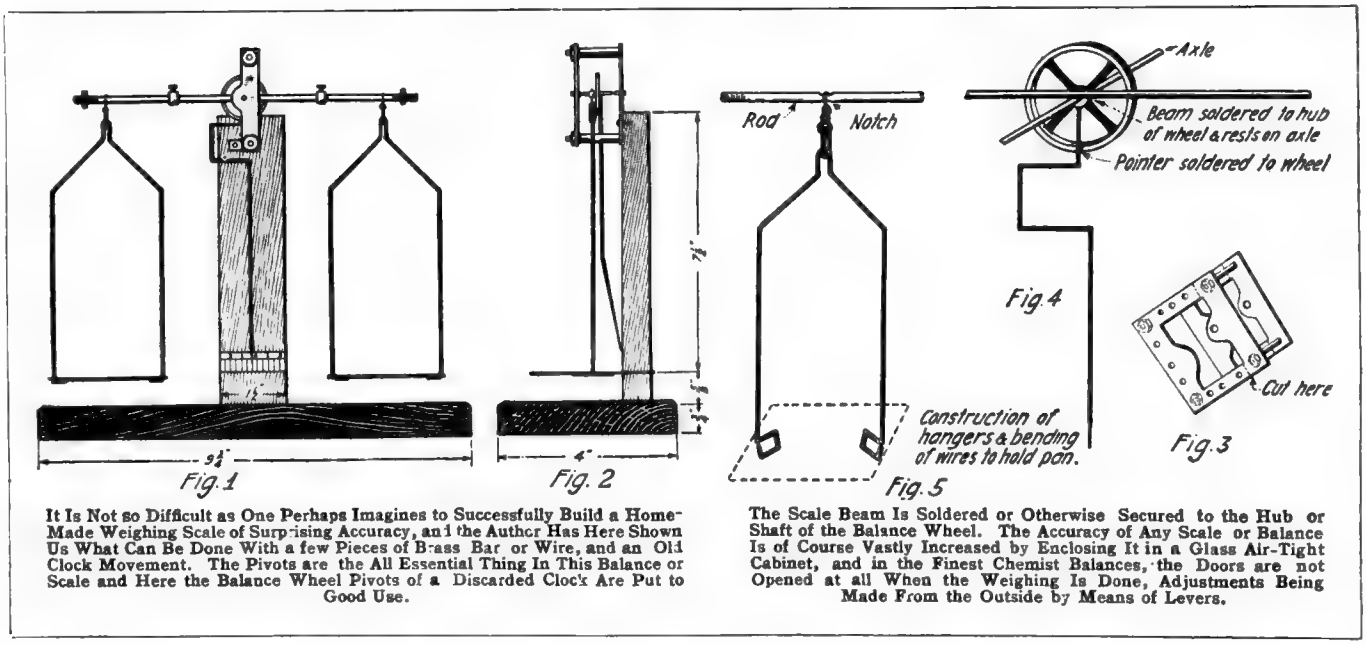
The balance is now ready for work and if the construction has not been slighted the pans will sink under the weight of a few milligrams. This is sensitivity enough for all ordinary purposes.

Watch glasses should be employed to hold chemicals when using the scale in order not to corrode the pans.

This balance when properly constructed and used will last for an indefinite time and is as efficient as more elaborate instruments sold at fancy prices.

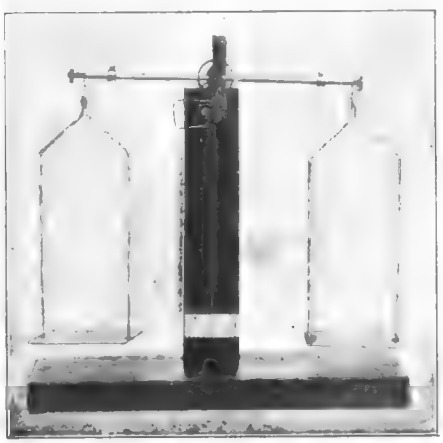
The question of weights is as important as the balance itself. The best way to get them is to make them yourself. The smaller weights up to a gram may be made of wire. Aluminum wire is suitable for the lighter and brass wire for the heavier ones. The sides as bent, will indicate the number of centigrams or decigrams in each. Thus a one centigram weight will be a straight piece of wire. The two centigram will be bent once giving two sides, and so on, up to the five centigram, which will have four bends and will be a pentagon with five sides.

For decigrams do the same using heavier wire. Borrow weights from an obliging friend and work yours out with cutting pliers and fine file. Or you may cut them out of sheet metal and stamp the numbers on them with figure punches. File them until accurate.



It Is Not so Difficult as One Perhaps Imagines to Successfully Build a Home-Made Weighing Scale of Surprising Accuracy, and the Author Has Here Shown Us What Can Be Done With a few Pieces of Brass Bar or Wire, and an Old Clock Movement. The Pivots are the All Essential Thing In This Balance or Scale and Here the Balance Wheel Pivots of a Discarded Clock Are Put to Good Use.

The Scale Beam Is Soldered or Otherwise Secured to the Hub or Shaft of the Balance Wheel. The Accuracy of Any Scale or Balance Is of Course Vastly Increased by Enclosing It in a Glass Air-Tight Cabinet, and in the Finest Chemist Balances, the Doors are not Opened at all When the Weighing Is Done, Adjustments Being Made From the Outside by Means of Levers.



Home-Made Chemical Balance for Experimenters Utilizing the Balance Wheel, Pivots and Bearings, Procured from a Discarded Alarm Clock. This Balance Possesses a High Degree of Sensitivity and Is Surprisingly Accurate.

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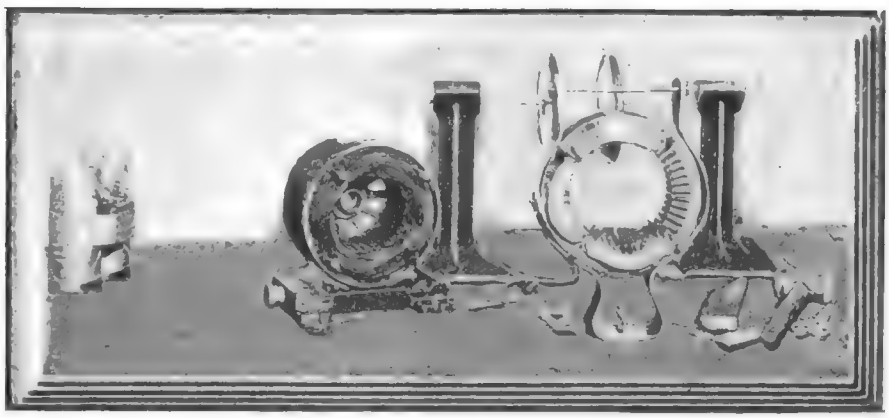
Motor Stator Rewinding Jig

To facilitate holding motor stators during rewinding operations a Massachusetts service company uses an interesting device. It consists of a flexible metallic holder constructed from a piece of strap iron. The piece of iron is about 28 inches in length and is bent into the shape of a clamp with the upper ends held in place by adjustable rods and bolts. The lower end is bolted to the bench. The whole outfit forms a receptacle with adjustability to a wide variety of motor frames ranging from 6 inches in diameter to 9 inches.

Contributed by ALLEN P. CHILD.



The Accompanying Photograph Shows a Simple Clamp for Holding Small A. C. Motor Stators or Fields While They Are Being Rewound. The Jig for Holding the Stator is Made from a Piece of Strap Iron Bent to the Shape Indicated.

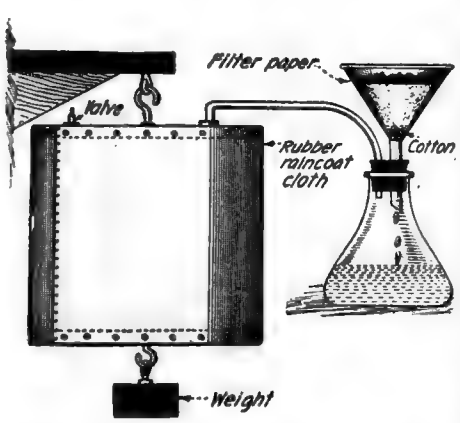
More Useful Wrinkles

A SIMPLE VACUUM FILTER

I am enclosing a sketch of a vacuum filter I made which is very efficient and works satisfactorily. I am sure that there are other experimenters wishing to filter things rapidly, who will be glad to have one of this kind.

It works on the principle of the bellows. The figure shows it complete. To make it operate the top and bottom are pressed together and the air is forced out of the valve which is placed over a hole in the top disc, thus letting the air out and none in. Then it is let go and the weight on the bottom will try to pull it into its original shape, thus drawing all the air from the bottle thru rubber tubing and into this pump, enabling the work of filtering to be done at a greater speed. Different sized weights can be hung on the bottom, thereby making the suction stronger or weaker. This device can be made any size; I had one 6″ in diameter but next I made one 1½′ in diameter and 2′ high. Any experimenter can find an old raincoat around the house which is about ready for the junkman. It is to be sewed before placing on the wooden discs, and rubber cement put wherever joints are to be made. A valve can be bought for 5 or 10c. and tacks such as are used for tacking the seats on chairs cost about 15c. The whole cost of making this is about 25 or 30c. If round boards are not available, they can be made. A tire valve is more efficient for the larger devices as it does not leak air. It should be inserted from the inside.

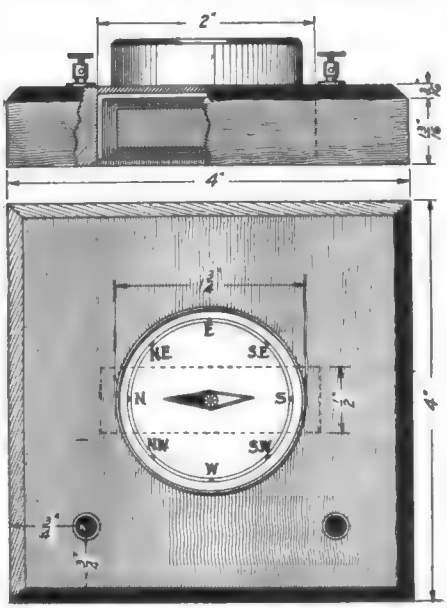
Contributed by ADOLPH F. LONK.



Speaking of Filtering Devices—and the Embryo Chemist Always Has One or More Doing Duty—Here is One That Will Tickle Your Fancy and It Is All Home Made. The Bellows for Creating a Vacuum Is Constructed from Rubber Cloth from an Old Raincoat, and is Provided With a Weight, as Shown. This Filter Works Very Fast.

A COMPACT GALVANOMETER

The accompanying sketch shows how to construct a compact galvanometer. Prepare a block of hard wood as illustrated, and in the bottom of this cut a channel about ½″ wide and 2½″ long and to a depth that will bring the bottom of the slot to within ⅛″ of the top of the block. Place two binding posts on it as indicated, then secure a good pocket compass about 2″ in diameter and fasten it in place with cement or by driving two very small brass nails thru the bottom. If the glass cannot be removed, solder the nails to the bottom, after having carefully removed the lacquer. The correct wiring will depend upon the strength of current used. It is, however, very easy to get an idea of what the deflection will be under certain conditions by merely making a preliminary trial. The winding may range from two to three turns of heavy wire to several hundred turns of fine magnet wire. The maker will have no trouble determining his particular wants. Finally the coil should be wound lengthwise on a small piece of wood and the whole packed neatly into the slot. Connect up the ends to the binding posts, and then glue in a thin piece of wood, to hold the coil in place. By drilling a small horizontal hole in the base and inserting a small bar magnet ⅛″ diameter or less, the instrument may be rendered independent of the earth's magnetism, and can be used without reference to the north point. Such a controlling magnet reduces the time required to bring the needle to rest after it has been violently deflected.



Every Electrical Experimenter Needs a Sensitive Galvanometer for Testing the Continuity of Spark Coil Windings, Etc., and a Very Effective Instrument Constructed from a Coil of Fine Magnet Wire and an Ordinary Pocket Compass, is Illustrated Above.

Contributed by STUART LORIMES.

ZERO DISCHARGE OF A DRY CELL.

We have generally discarded dry cells immediately after they do not display the usual "pep." However, it has hardly ever been mentioned at just what state a "dead cell" really is dead. For further information on the subject I investigated a so-called "dead" cell—and it was DEAD, for it would not move my ammeter. However, it did make quite a deflection on my milliampere meter (a very sensitive instrument manufactured by A. Gaffie, Paris, France). This meter reads from zero to 250 milliamperes.

The first reading as shown in the table below was 5 milliamperes. Owing to the fact that the resistance of the meter was but .18 ohm, the battery was practically shorted during the tests. This made it practicable to reduce the battery to zero. The following are the results of various readings:

Time.	Amperes.
12:00 Noon	.0050 amp.
12:02 P. M.	.0030 amp.
12:03 P. M.	.0025 amp.
12:06 P. M.	.0020 amp.
12:10 P. M.	.0017 amp.
12:15 P M.	.0014 amp.
12:25 P. M.	.0012 amp.
12:35 P. M.	.0010 amp.
12:45 P. M.	.0009 amp.
2:30 P. M.	.0008 amp.
6:45 P. M.	.00075 amp.
7:10 P. M.	.0005 amp.
8:15 P. M.	.0003 amp.
9:30 P. M.	.00015 amp.
10:00 P. M.	.0001 amp.
10:35 P. M.	.00009 amp.
11:12 P. M.	.00000 totally discharged

This is a test which while having no definite bearing on the future of batteries is unique when it is realized that in order to follow any battery to Zero ampere current strength it requires very sensitive laboratory instruments, such as were used in this instance, and the average learned experimenter has no idea of just what current a battery still maintains after being actually discarded from service. Such old battery cells are useful for testing work and other small current applications in many instances.

Contributed by E. T. JONES.

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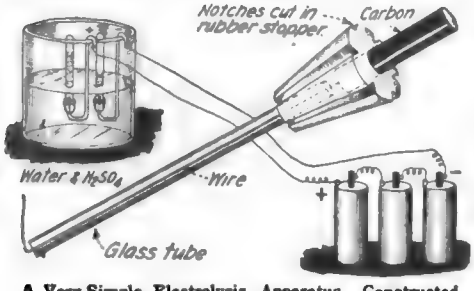
ELECTROLYSIS OUTFIT

The accompanying diagrams show a simple form of electrolysis outfit; which I have used very successfully in demonstrating and in experimenting in the Berlin City High Schools.

This apparatus which I found very useful in my work, is also very easy and cheap to make, for the boy who is interested in ionic action, and also for the experienced experimenter, who wishes a simple set, but does not wish to go to the expense of buying one from a scientific apparatus company.

The materials necessary are two one hole rubber stoppers (No. 1), two feet of glass tubing of a size to fit the holes in the rubber stoppers, and two carbons, which can be found in a laboratory, or can be taken from a small used flashlight battery, and three feet of ordinary copper wire of any convenient size, as long as it is not too large. Other materials outside the set necessary for operation are test tubes, and a six inch battery jar. Any beaker may be used in place of the battery jar if it is deep enough.

First cut the glass tubing and copper wire into two equal pieces, then take the carbons which are about 2" long and ¼" in diameter and attach the copper wire. This is done by filing a groove about ¼" from the end with a triangular file. Also a groove from the circular one to the end of the carbon. The copper wire is now fitted into the groove and made fast by soldering. Now enlarge the holes on the large end of the rubber stoppers, enough to accommodate the carbons and fit in the carbons about one-half the length of the rubber stoppers. Do not enlarge the hole entirely thru the rubber stoppers or the glass tubing will not fit. The carbon is now fitted tightly into the rubber stoppers, with



A Very Simple Electrolysis Apparatus, Constructed from Two Glass Test Tubes, Two Rubber Corks and a Pair of Carbon Electrodes. This Arrangement of the Apparatus Obviates the Necessity of Having Any Elaborate Glass Parts Made. The Acidulated Water Is Decomposed When the Current Is Passed Thru It, Hydrogen Gas Being Evolved at the Negative Pole and Oxygen Gas at the Positive Pole, There Being Twice as Much Hydrogen as Oxygen.

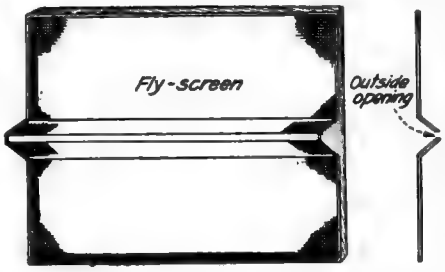
the copper wire extending thru the small hole. The pieces of glass tubing are placed over the copper wire and fitted tightly into the rubber stoppers at the small ends. If carbon and glass tubing do not fit tightly in the rubber stoppers strong fish line may be tied around the ends of the stoppers. The glass tubing is now ready for bending. Care must be taken that the glass is not bent too suddenly or the wire will be forced thru the soft glass tubing. Make a right angle bend 1½" from the rubber stopper; 1" from this bend make another right angle bend in the same plane and 4" from the second another right angle bend in the same plane, and finally make a bend to hook over the battery jar to hold the apparatus in place. Seal the glass tubing at the ends around the copper wire by heating. Both are made in the same manner and these bound or sealed together to make them rigid.

The set is now ready for operation. The battery jar is filled well above the carbons with the solution to be studied, say brine (water in which salt, Na Cl, has been dissolved). Fill two test tubes with the solution and invert them over the carbons. Attach two or three dry cells or a 110 volt D. C. with a large lamp in series and at once bubbles of gas will be seen in the tubes.

Contributed by J. H. THORNGATE.

AN IMPROVED FLY SCREEN

The slit across the middle of the screen was made by bending the two edges outward after cutting and fastening the ends together with wire, so as to form a triangle, so that there will be about a quarter inch



The Simplest Fly Screen Imaginable—the Inventor Claims, That, By Darkening the Room, the Flies Will Pass Out Thru the Small Opening Here Provided in the Screen, But That After Watching for a Long Time, Not One Fly Was Ever Seen to Come Back Thru it.

opening or outlet in the slit, which, when placed in the screen, is so put that the V points toward the outside of the window. The screen was placed in the window and the shades pulled down so that the room was made comparatively dark. The flies which were in the room flew toward the light, which came in thru the bottom part of the window containing the screen and as they walked up this screen, with this outlet, they naturally walked out thru the opening and escaped, and I have never seen even after hours of observation, one single fly, come in thru this opening.

Contributed by C. H. THOMAS.

NOVEL GLASS RULER

We have found that a glass tube from ½" to ¾" in diameter and of any suitable

A Glass Rule Can Easily Be Constructed From a Piece of Glass Gauge Tube, Such as Used on Water Gauges on Boilers, and, if Desired, Colored Cotton or Silk May Be Placed Inside of it, or a Paper Scale Could Also Be Placed Within it and the Ends Corked.

length, packed with cotton waste makes a serviceable ruler. The tube should be sealed at both ends with a cork and sealing wax. If colored waste be used, that is several colors mixed together, it will make a pretty effect. Cotton waste with colors black, white, blue, red, and yellow mixed, can easily be obtained or made and old gage glasses can be used.

Contributed by WM. GEO. EAMES.

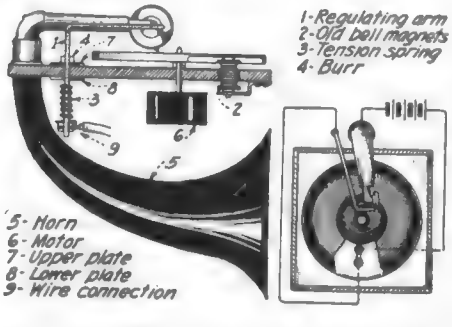
SELF-STOP FOR PHONOGRAPH

Perhaps a number of the readers of *Science and Invention* find themselves getting ready to shut the phonograph off, which takes away a lot of the charm of the music when you have to be thinking all the time.

In the illustrations I have shown how to make a simple self-stop for your phonograph, and by studying them carefully you may easily understand how it works. The regulating arm which is the only part that you have to construct is made of ¼" brass rod, or it can be an iron rod which has been nickel plated. Almost any small stiff spring will do for the tension spring. This spring is to hold the arm in any position that you desire, and keeps the reproducer from moving it towards the center of the record.

When the regulating arm and the reproducer touch each other an electric circuit is closed, and the electro-magnets stop the turntable. The position of the regulating arm is varied, according to the last grooves in the record. The electro-magnets can be taken out of an old electric door bell, or they can be bought at some electrical supply house. Connect the regulating arm, battery, and magnets as shown in the diagram; one or two dry batteries are needed, which can be put on the inside of the phonograph. This automatic stop has worked very successfully.

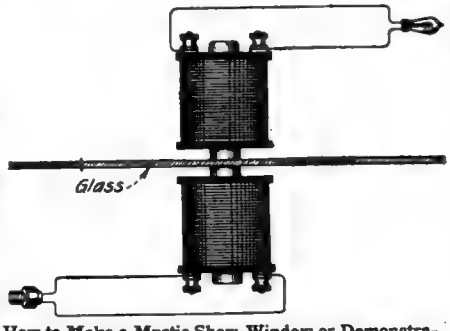
Contributed by I. W. RAUSCH.



An Automatic Electro-Magnetic Stop for the Phonograph Can Be Constructed on the Plan Here Shown. The Regulating Contact Arm is Set for Each Record, So That When the Reproducer Needle Reaches the Last Groove, the Reproducer Will Hit the Contact Arm and Close the Magnet Circuit, and Arrest the Rotation of the Disc.

TRICK LAMP LIGHTING

Here is a novel stunt which is sure to please, and with proper *patter* talk it can be used as a magic trick. The following is a description of the device that will light a 32 volt Mazda lamp on the outside of a front (plate glass) window with a 110 volt A.C. attached on the inside. Take wooden blocks



How to Make a Mystic Show-Window or Demonstration Lamp—the Lamp is Lighted By Alternating Current Induced in One of the Coils Comprising the Transformer Shown, the Primary Coil Being Connected With the 110 Volt A. C. Lighting Circuit.

3½x3½" square and 1½" thick, bore a hole in the center of the block small enough, so that an inch gas-pipe nipple will screw in tight having a thread long enough to screw thru the head to allow a pipe cap to screw on to one end, and the nipple is screwed into the other end; the nipple is 4" long. When you have the core completed in this way, proceed to wind as follows: First lap a few layers of wrapping paper around the core, the winding can be done by hand and the core held in a small vice provided for the purpose. Wind this with No. 24 magnet wire. Turn the core towards you and wrap the wire close to the end and back. Put on another layer of paper, and repeat this five times, after which you will have ten layers of wire. Two coils are made exactly alike. It does not matter which coil you attach the A.C. circuit to. Attach to one of them an attachment plug, and to the other a lamp socket (the attachment bolts, as shown, can be omitted). Put in the socket a 32 volt Mazda lamp for the outside circuit and to the other one a snap switch socket, attached to a 110 volt A.C. circuit for the inside. Have the one, that has the lamp attached to it, taken to the outside and place the end of the core against the glass. If this coil is now moved around until finally it comes in position over the 110 volt coil the lamp will light up.

Contributed by D. C. WOLFE.

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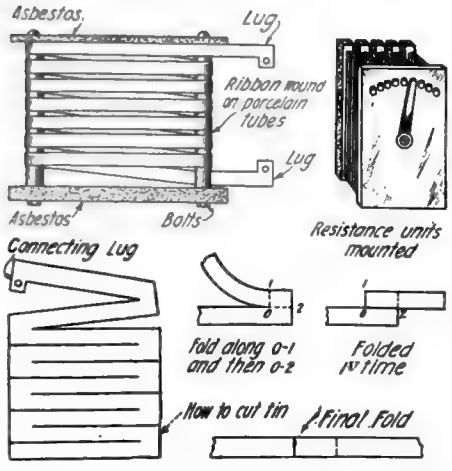
HOW-TO-MAKE-IT

This department will award the following monthly prizes: First prize, $5.00; second prize, $3.00; third prize, $2.00.
The purpose of this department is to stimulate experimenters toward accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department a monthly series of prizes will be awarded. For the best idea submitted a prize of $5.00 is awarded; for the second best idea a $3.00 prize, and for the third best a prize of $2.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $5.00

MAKING A RHEOSTAT FROM A TIN CAN

Ever get "hard up" for resistance wire? Well, don't worry about that if you have any tin cans in your back yard, why not use them for resistance? Melt the ends out of the cans and cut out the seams. Flatten out the tin and cut it in strips about 3/16th of an inch wide, leaving a square piece at each end for connections. Then the tin may be folded so as to make one straight strip. Cut two pieces of asbestos about 3/8"x1/2"x26" and drill a 1/8" hole, about 1" from each end on both pieces. Attach two



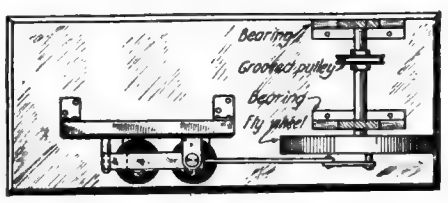
Tin Can Rheostats! Ever Heard of Them Before? Well Here's How One Experimenter Found a Use For the Old Cans Decorating the Ash Dump. The Tin is Flattened Out and When Cut, as Shown, Makes Excellent Grids for Rheostats.

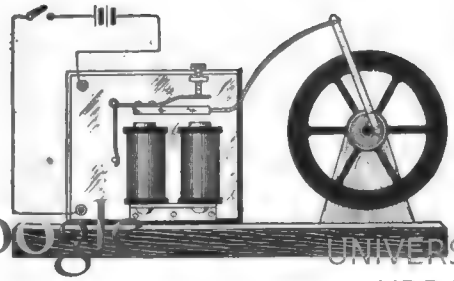
8" porcelain tubes to the asbestos by means of bolts. On this frame, the tin strip may be wound. The completed resistance units may then be mounted. Sets of these resistance units may be combined by the builder to make a rheostat, or they may be tapt off. There is enough tin in a quart can to make one of these units (about 30 ft. of strip). Two of the units in series will safely pass 10 to 15 amperes thru an outside circuit, at a potential of 110 volts.

Contributed by ERTELL M. WATSON.

TOY MOTOR

Here is a simple toy motor made from an old wooden base electric bell. Of course the iron base type may be used, but a wooden base bell has been proven superior because it is easily attached to a base. First fasten a wooden or metal fly wheel to a shaft in such a manner that the fly wheel is flush with one end of the shaft. Place





An Electric Motor of Very Simple Design—It Is Built From a Vibrating Electric Bell, Together With a Fly Wheel, Shaft and Connecting Rod. When the Parts are All Adjusted and the Armature Vibrates, the Balance Wheel Will Be Rotated Continuously.

a pin in the fly wheel a little off center. The shaft is carried by two sheet metal bearings, and riveted up slightly on its ends, to prevent it from slipping back and forth. The clapper of the bell is then removed and the end of the stem bent to a proper angle. With the fly wheel and bell in position, connect a thin strip of metal the size of which will have to be determined by trial; so that it may turn freely on the bent end of the bell clapper, and also on the fly wheel pin, two holes being drilled in this metal strip to receive the pins. It is not necessary with this type of motor to employ a commutator, as the circuit breaker upon the bell will answer this purpose. Everything being properly adjusted, one or two dry cells will operate the motor so formed, for quite a long time and if a pulley is provided small toys may be run with it.

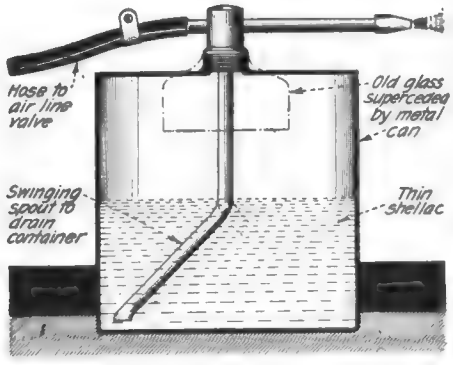
It is surprising how many useful and different electrical devices, especially motors, can be constructed from old bell magnets. In the interesting book for experimenters called, "Electric Toy Making," by Prof. T. O'Conor Sloane, many unique and practical ideas are given, showing similar but more improved types of motors utilizing such parts as electro-magnets from bells, etc. These small electric motors can be operated from batteries.

Contributed by BENJAMIN LADNER.

SECOND PRIZE, $3.00

A PAINT SPRAYER

The writer has recently concluded some interesting experiments in the spraying of paint. A certain factory was equipt with



By Utilizing the Spraying Mechanism From an Old Atomizer, One Can Make a Very Useful Paint and Shellac Sprayer, as Shown in the Accompanying Illustration.

a large size paint spraying machine, permanently mounted in its painting department, but it was necessary to do some light work, outside of this department, and the research finally led to the adoption of the following stunt in the pattern making department.

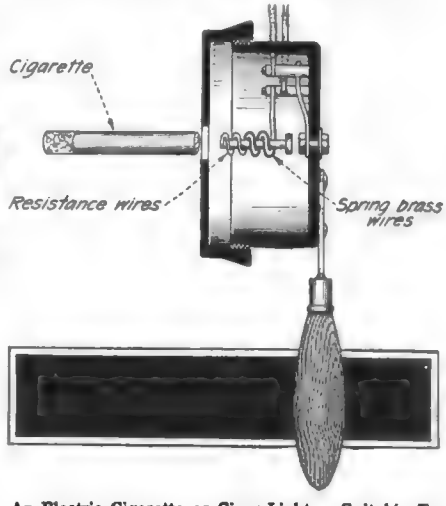
The sketch herewith shows a commercial atomizer of the type used for nose and throat as adapted to spray shellac. It was found that the work was done in a mere fraction of the time required for brushing and done better, and that less than half of the amount of shellac was required. The air was taken from the pressure air line at 90 pounds and reduced to 55 pounds for this purpose with a standard reducing valve taken from an old discarded oxy-acetylene welding apparatus. One of the results of the experiments was, that a discovery was made, that this could also be used with a reduced nozzle for lettering, using lamp black paint in the shipping room, and that a man handy with lettering could mark fifteen packages to one marked by stencil in the same time.

Contributed by W. BURR BENNETT.

THIRD PRIZE, $2.00

ELECTRIC CIGAR LIGHTER

Why not build an electric cigar or cigarette lighter from an old telephone receiver shell, as I have done? First remove the magnets, and any other superfluous material; then make a coil of spring brass wire and attach to this a piece of resistance wire, as illustrated. A mica diafram is placed in the receiver, the wire passing thru two holes made for that purpose. Upon pressing on the cigar or cigarette, as it is thrust thru the little hole in the receiver cap, a



An Electric Cigarette or Cigar-Lighter, Suitable For Use on Motor Boats or Automobiles, etc. When the Cigarette or Cigar is Pusht Against the Spring Suspended Coil Made of Fine Resistance Wire, the Circuit is Closed, and the Wire Gets Red Hot. The Length and Size of the Wire Will Have To Be Proportioned for the Battery to be Used in Each Case

circuit is closed; the resistance wire heats up, and presto! your cigarette is lit. The size of the resistance wire and the thickness will depend upon the circuit on which it is being used, and a handle attached to the receiver gives a very serviceable article.

An electric cigar or cigarette lighter of the type here suggested is very useful to those driving automobiles or motor boats where it is almost impossible to light the cigar or cigarette with a match owing to the wind.

Contributed by GILBERT LOWRY.

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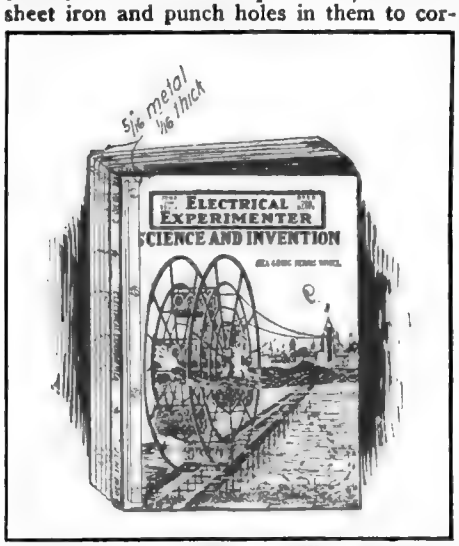
More "How-to-Make-It"

SIMPLE WAY TO PRESERVE YOUR "E. E." and "S. & I."

Six copies of the magazine should have three small holes punched or drilled in the back edge of them at equal distances. Secure two narrow strips of tin, brass or sheet iron and punch holes in them to cor-



Here Is a Simple and Economical Way in Which to Bind Back Numbers of "Science and Invention," by Means of Two Metal Strips and Two or More Stove-bolts Passing Thru Holes Drilled or Punched in the Magazine.

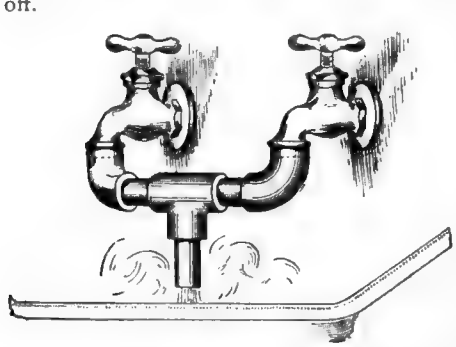
respond to the holes in the magazines. Next secure three small stove bolts (about 3-16 by 1 inch) and put them thru the first strip, then the magazines and place the second strip on top. Draw the nuts up tight and the job is complete.

I have found this to be a very satisfactory way of preserving my "S. and I.", as the covers are heavy enough to protect them, if they are simply held in shape, as explained.

Contributed by ELTON S. BROWN.

HOME-MADE "WARM WATER" MIXER FOR COLD MORNINGS

During the biting cold weather one usually has no inclination to wash in the morning with water of a like temperature. Very hot water is just as unpleasant, and one usually resorts to mixing the water to the right temperature in the basin. The water may be mixed to the desired temperature while it runs by the use of a very simple home-made device. Two pieces of rubber tubing should be forced on to each end respectively of a standard "T" pipe fitting. These pieces should be long enough to extend to and fit on to either faucet as shown in the sketch. The tubing should be fastened to the "T" pipe fitting with strong hemp cord so that it does not pull off.



We Are All Familiar with the Convenience Afforded by the Combination Hot and Cold Water Spigot Fitted on Bath Tubs, and This Genius Shows Us How to Achieve the Same Results with a Few Pipe Fittings or Rubber Tubing Attached to the Usual Spigots.

A GOOD ELECTRIC WELDER

The accompanying sketch will convey the idea of the A. C. Welding Outfit made in our Repair Shop, which has given very excellent service on light welding. The transformer coils of a 20 horse-power, three phase, 220 volt motor starting compensator were connected as illustrated in Figure 2. The three coils were connected in series across the line, the voltage of which line was at a pressure of 220. A set of taps were brought to a switch to permit voltage adjustment. One side was used as a ground and a lead, placed in

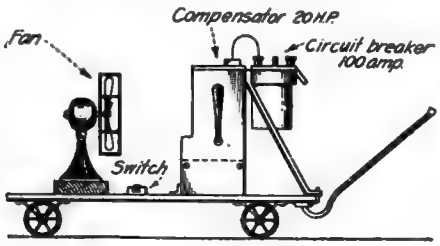


Fig. 1

The Portable Electric Welder, Shown Above, Was Actually Built and Gave Excellent Results, the Author States. It Operates on Alternating Current and an Electric Fan Is Used to Help Cool the Auto-Transformer Coils Employed, Which Coils Were Obtained from a 20 H.P. 3 Phase, 220 Volt Motor-Starting Compensator

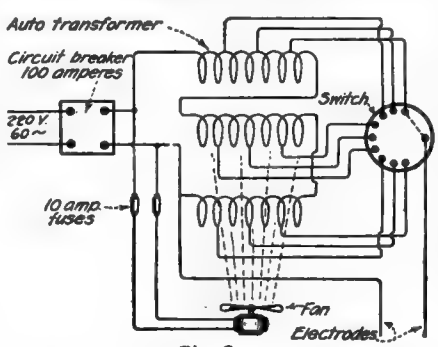


Fig. 2

This Diagram Shows How the Auto-transformer Windings Are Connected for Use in Controlling the Amount of Current Used on the Electric Welder. The Current May Be Varied by Means of the Switch, Shown at the Right of the Diagram.

Fig. 3

Invariably the Electrode Used in Welding with the Arc Was of the Type Generally Employed in Carbon Arcs, in Other Words a Piece of Arc Carbon. This Carbon Was Held in a Brass Tube, the End of Which Was Secured in a Fiber Bushing, as Illustrated in Fig. 3 Above

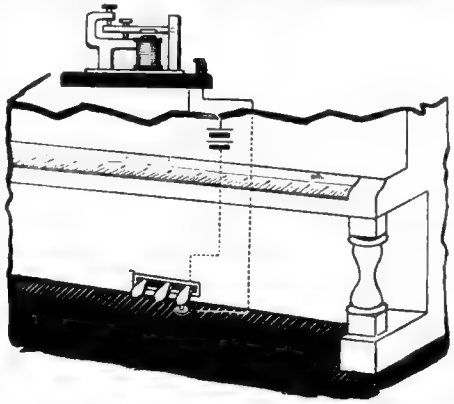
series with the coils, was led to the carbon electrode. A circuit breaker of the oil-immersed type was used as the protecting element. A nine-inch desk fan was mounted in front of the coils to assist in cooling them; it was thus possible to use the welder continuously with the fan operating, or it may be used intermittently when the fan is omitted. Invariably, the electrode used was of the type generally used in carbon lamps. This was held in a brass tube, the end of which was secured into a fiber bushing, as illustrated in Figure 3.

The welder should wear black or blue glasses and leather or metal shield over the handle of the carbon electrode holder, the hole in the center being of the correct size to just slip over the fibre tube of the welding device, illustrated at Fig. 3.

Contributed by PERCY LLOYD.

TRY THIS STUNT ON YOUR PIANO

A very unique and entertaining (also sometimes exasperating) attachment may be easily installed by musically inclined experimenters, for their own amusement.



A Curious Little Stunt Which Will Provide Quite a Lot of Fun Especially to the Uninitiated, Is Illustrated in the Diagram Above—It Involves the Connection of a Telegraph Sounder or Bell Together with a Battery to the Soft Pedal of Your Piano. Every Time This Pedal Is Deprest the Sounder or Bell Will Act. Many Other Tricks of a Similar Nature Will Suggest Themselves to the Experimenter.

This is but a suggestion and the ingenious experimenter will readily be able to work out other more devious schemes perhaps, for surprising his friends. An electric horn such as is used on automobiles and connected to one of the piano pedals in this fashion will perhaps be more musical and at the same time cause an effect quite startling and surprising to those who are not onto the stunt. Come to think of it, why not obtain or build eight or more electric horns of the buzzer or vibrating diafram type, and connect these up with a common battery to a special pedal board, containing one pedal for each horn. thus enabling musical accompaniments to the piano to be played with the feet?

Contributed by J. J. COPELAND.

DETECTING FINGER PRINTS

Procure about half a teaspoonful of iodine crystals and put them in a test tube. Heat the bottom of the test tube over an alcohol lamp. You will notice that a purple vapor is generated.

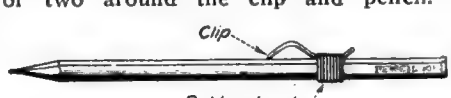
Hold the piece of paper which has been handled and on which you want to detect the finger prints, over the iodine vapor.

You will at once see the finger prints come out on the paper.

Contributed by W. DITZENBERGER.

PENCIL CLIP MADE FROM PAPER FASTENER.

Take a common paper clip, and bend one end about half an inch from the end, also bend the other end, but in the opposite direction. Place the clip on the pencil with the raised part towards the top of the pencil. Wind a rubber band or two around the clip and pencil.



This Is One of the Simplest and Most Effective Pencil or Pen Clips for Holding the Pencil in the Pocket, That We Have Ever Seen. It Is Made from a Wire Paper Clip Bent to the Shape Shown and Then Held in Position by a Rubber Band Doubled Over Several Times.

Place pencil in pocket and raise the clip by pressing on the raised part, this will allow the pencil to clamp on pocket.

Contributed by
HERBERT W. NEANDER.

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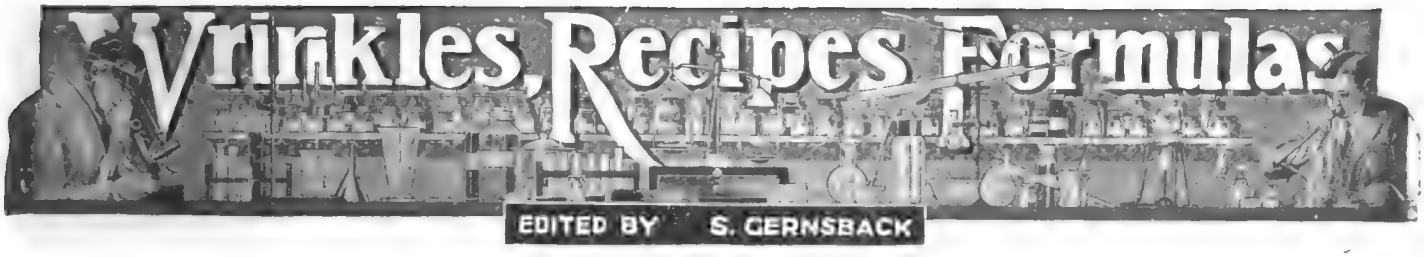

HOW TO MAKE LUMINOUS MATERIAL

By Elton R. Darling

LOOKING over the rail of a steamship into the southern waters about dusk one is fascinated by the light flashes in the water. To add to the mystery there does not seem to be any apparent cause for the phenomenon. As the darkness settles these flashes become brighter and brighter which creates an interest to while away the evening hours. The cause is discust, but the truth seems deep seated. Marine life is responsible for it, and when removed from the water the light is lost. One point of interest is the fact that there is no evidence of heat.

During the summer evenings our attention is directed to the fire-fly as it darts to and fro giving forth its occasional flashes, as tho it was a means of finding its way around. When one catches the insect the flashes continue, but like the marine life of the southern waters, there is no evidence of heat.

To duplicate this accomplishment of nature has been the ambition of man. "COLD LIGHT." Think of the thousands of uses to which it could be put.

Centuries ago marine shells were heated to incandescence and would then give forth a bluish light even when cold, but this could not be depended upon. Later when phosforous was discovered it was found that by dissolving in oil a light-giving fluid could be obtained. This however served only a limited purpose. It was kept in a stoppered bottle, and on opening the bottle and perhaps shaking it a little, a faint light would be produced.

Chemical research next took up the subject and rapid advancements were made in this direction. Pitchblende was found to contain radium, the element of unlimited energy. But a milligram is worth $100.00. The question was—could this be locked up so that it would be within the means of everyone?

Specially prepared zinc sulfid was found to be invaluable in blending with radium salts, and by so doing giving forth a constant and dependable light. The amount of radium required was very small yet a light sufficient for many purposes was obtained.

Another point of interest was that the zinc sulfid itself was capable of giving out a strong light for some time and this could be strengthened by again exposing it to strong light. So the zinc sulfid could be used without the radium salts for many purposes.

Is it difficult to prepare? "NO." Any boy with a good chemical set can make it. The main thing is care and the use of pure chemicals, for it is a very fussy operation. Just think, boys, of having a bottle of this luminous zinc sulfid to show to your friends. Take them into a dark room and then see it glow. Pass it around and prove to them that there is such a thing as artificial light without heat.

HOW IT IS MADE

First obtain some pure zinc. The zinc must be pure to have the process work out successfully. Then add to this pure concentrated hydrochloric acid until no more will dissolve. Look out for spattering of the acid on yourself. This must then be filtered thru asbestos. Filter paper cannot be used as it will dissolve the paper. Then add to it pure concentrated ammonium hydroxid until the precipitate which is first formed redissolves. Then to it add a few c.c. of ammonium sulfid and after well shaking, set to one side in a warm place over night. In the morning this is again filtered and a clear, colorless solution should result. To this is then added an equal volume of distilled water and pure hydrogen sulfid run in until the whole is well saturated. It is then filtered thru a hard filter paper and allowed to drain. Do not wash the precipitate with anything. When well drained scrape the precipitate into the bottom of the filter paper with a porcelain spatula. The precipitate which is obtained is then in a condition to be removed from the funnel. The whole is then removed and the filter paper folded around the precipitate and the whole placed in an evaporating dish or porcelain crucible and this in turn placed in a hot oven to dry. The heating must be continued until the paper is charred and the precipitate a hard white mass. The whole, filter paper and all, is placed in a clean mortar and ground to a fine powder. To every 50 grams obtained there is added 10 grams of flowers of sulfur, 5 grams of sodium chlorid and the whole is well mixed. This is then placed in a crucible and covered. It is then heated over a Merkel burner for about 40 minutes, allowed to cool and the resulting product should be luminous if you have used care and followed directions.

To make a paint with it add it to white shellac dissolved in alcohol. Paint with a small brush and when dry the object will be luminous. You can paint the hands of your watch, the keyhole escutcheon on the door, the number of your house and hundreds of other objects.

[Editor's Note: The greatest care should be taken in the use of strong acids. The danger consists not only in spilling them on one's clothes or one's person, but there is liable to be a certain amount of spray given off in dissolving substances in them, or in evaporating or boiling them. Work with small quantities, wear a chemist's rubber apron, and use care.]

A GOOD JEWELER'S ROUGE

Saturate a solution of iron sulphate (Green Vitrol) with a solution of oxalic acid. Filter and dry the resulting precipitate of pale-yellow oxalate of iron; place it in an iron dish and expose it to a moderate heat, whereby the oxalic acid will be decomposed and expelled, and a pure sesquioxide of iron will be left. This is very fine and can be used for producing a very brilliant polish on any jewelry.

It also makes an excellent polish for work which has been electroplated.

Contributed by H. J. RUNDT.

PROTECTING FINGERS FROM CHEMICALS.

The finger nails and fingers may be easily protected from stains of chemicals by coating them with a wax made up as follows: Melt white wax in the same manner as melting glue. This may be done by cutting the wax into small pieces, placing them in a vessel and setting the vessel in boiling water. To each ounce of melted wax thoroly stir in one dram of pure olive oil. The fingers should be dipped into this wax while it is in a liquid state. This will form a coating which will permit the free use of fingers yet protects the skin from the chemicals.

Contributed by H. J. RUNDT.

Names of Common Chemicals

I have found, in my line of work, that some of the most reliable formulae were those printed years ago, and, of a necessity, cluttered up with the nomenclature of that period. It has cost me hours and in one instance more than a week of tiring search thru many volumes in order to be able to translate the obsolete terms of a formula into the ones now in use. Few employees of drug stores and supply houses know obsolete chemical names. The following is useful

By J. H. Schalek

Old Name	*Modern Name*	*Formula*
Alabaster	Calcium sulfate	$CaSO_4$
Argol	Potassium hydrotartrate	$KH(C_4H_4O_6)$
Black Ash	Sodium carbonate + calcium sulfid	Na_2CO_3+CaS
Blende	Zinc sulfide	ZnS
Bone Ash	Calcium phosfate	$Ca_3(PO_4)_2$
British Gum	Dextrin	$C_6H_{10}O_7$
Butter of Antimony	Antimony trichlorid	$SbCl_3$
Calamine	Zinc silicate	$(ZnOH)_2SiO_3$
Chili Saltpeter	Sodium nitrate	$NaNO_3$
Chrome Ironstone	Ferrous chromite	$FeO.Cr_2O_3$
Condy's Fluid	Potassium permanganate	$KMnO_4$
Green Vitriol	Ferrous sulfate	$FeSO_4.7H_2O$
Dolomite	Calcium-magnesium carbonate	$CaCO_3.MgCO_3$
Eau de Javelle	Pot. hypochlorite + chlorid	$KClO+KCl$
Essence of Mirbane	Nitro-benzene	$C_6H_5(NO_2)$
Soapstone	Magnesium silicate	$(MgO)_3.(SiO_2)_4.H_2O$
Fusel Oil	Amyl alcohol	$C_5H_{11}OH$
Galena	Lead sulfid	PbS
Horn Silver	Silver chlorid	$AgCl$
Massicot (Litharge)	Lead oxid	PbO
Lunar Caustic	Silver nitrate	$AgNO_3$
Milk Sugar	Lactose	$C_{12}H_{22}O_{11}$
Nordhausen Acid	Sulfuric acid + sulfur trioxid	$H_2S_2O_7$
Orpiment	Arsenic sulfid (yellow)	As_2S_3
Pearl White	Bismuth nitrate	$Bi(NO_3)_3$
Pink Vitriol	Manganous sulfate	$MnSO_4.4H_2O$
Pearl Ash	Potassium carbonate	K_2CO_3
Pyrogallic Acid	Trihydroxybenzene	$C_6H_3(OH)_3$
Pyroligneous Acid	Crude acetic acid	$H(C_2H_3O_2)$
Realgar	Arsenic sulfid (red)	As_2S_2
Colcothar	Ferric oxide	Fe_2O_3
Saltcake	Sodium sulfate	Na_2SO_4
Salts of Lemon	Potassium binoxalate	$KH(C_2O_4)$
Salts of Sorrel	Oxalic acid	$H_2C_2O_4$
Salts of Tartar	Potassium carbonate	K_2CO_3
Scheele's Green	Copper arsenite	$Cu_3HAs_2O_6$
Sedative Salts	Boracic acid	$B(HO)_3$
Soda Ash	Sodium carbonate	Na_2CO_3
Spirits of Salt	Hydrochloric acid	HCl
Stassfurt Salts	Potassium chlorid	KCl
Cinnabar	Mercuric sulfid	HgS
Wall Saltpeter	Calcium nitrate	$Ca(NO_3)_2$
White Precipitate	Mercur-ammonium chlorid	$HgCl_2(NH_4Cl)_2$
White Vitriol	Zinc sulfate	$ZnSO_4.7H_2O$

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RADIO DEPARTMENT

Overcoming "Static" in Radio News Reception

By ARTHUR H. LYNCH

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Those Familiar With the Problems Which Have Confronted the Regular Reception of Long Distance Radio Messages, Especially News Reports Transmitted Across the Atlantic, Have Undoubtedly Often Wondered If There Was Not Some Way by Which the Troublesome "Static" and Other Interference Could be Overcome. By Arranging a News Reception System, as Shown, Along the Atlantic Seaboard and Linking the Respective Radio Receiving Stations Together Either By Telegraph, Telephone, or Short Range Radio, It Has Now Become a Simple Matter to Pick Up the Long Distance Radio Message at a Station Not Momentarily in the Static or Interference Zone, as Becomes Apparent by Studying the Chart Reproduced Herewith, and Then to Relay the Message to the Newspaper in the Static Zone.

WITHIN the past few weeks one of the greatest developments of radio transmission, in its application to the receiving of news from Europe, has been undertaken by one of the leading dailies in this country. The development is of such scope, and based upon such scientific development, as to be of international interest. This is especially true, when it is considered that the press in America has been agitating, for some time past, the use of some of the U. S. Naval Radio Stations, for the interchange of foreign and domestic news. It has been claimed by the interested parties that the cables are congested, and that important news from foreign countries, especially those across the Pacific, has been delayed.

In matters of radio and other forms of communication the views and decisions of Rear Admiral Willliam H. G. Bullard have come to be viewed with great interest by the communication companies and the representatives of the press. His work, in connection with the perfecting of the communication service of the U. S. Navy, is looked upon by experts as being of the highest order. At a conference, held in Washington last December, between editors and attachès of the radio companies, which are interested in trans-ocean press, the Admiral said, in part:

"I have urged that we should get the news of this country out and the news of foreign countries in, because the more we know about other people, and the more they know about us, the more friendly we will become. Until very recently all the American news, that Porto Rico got, filtered through London and Paris and received a foreign color. The Navy service has been open for months to the American press and for commercial purposes. It is regrettable that it has not been used."

When asked about the status of the communication service between this country and Porto Rico not having been brought to the attention of the press, the Admiral explained, that the Navy could not advertise for business. Further developments, at the conference, showed that the Naval radio stations, which had been exchanging press news with France, were closed for that service because the Radio Corporation of America had advised the authorities that it was in a position to handle such commercial traffic. It developed, however, that the traffic was too great for the corporation to handle, and the naval service was again opened, though no notice of the resumption of that service was given to the press. The attitude of the government in matters of this kind is not to interfere with the growth of private enterprise by competing with it, unless the service of the private operators is inadequate for the proper handling of the business.

The desire of the press was to have the naval service opened for press use until such time as the regular commercial service could accommodate it.

(*Continued on page* 383)

In August "Radio News"

Radio Helps in Fighting Forest Fires — *By S. R. Winters*

Radio Apparatus for Amateurs — *By G. Y. Allen*

Radio in a Country Town — *By Armstrong Perry*

An Arc Transmitter With Unusual Features — *By Charles R. Leutz*

Construction of High Voltage Step-Up Transformers — *By H. W. Secor*

Radio Helps Where Time is Money — *By Arthur H. Lynch*

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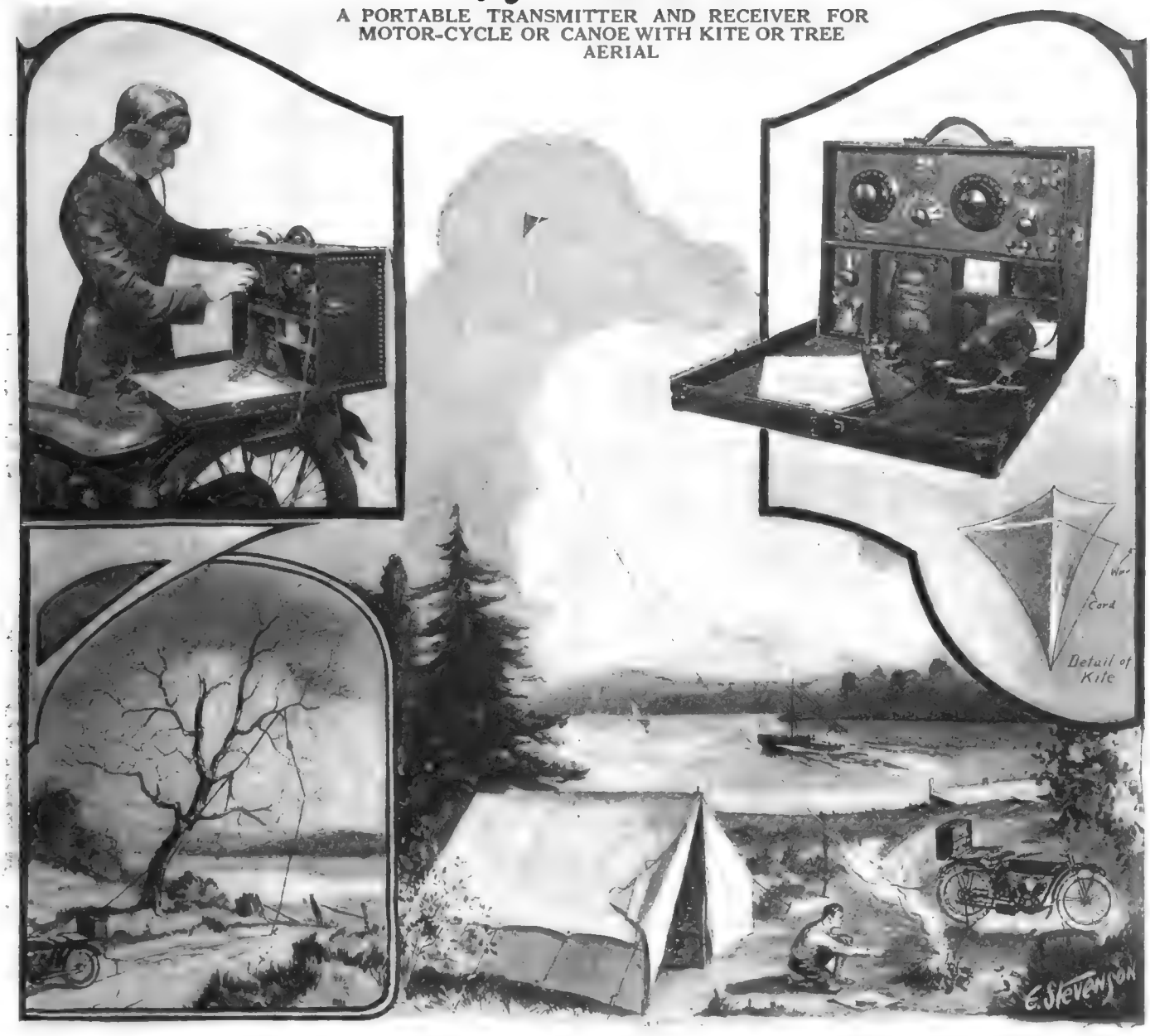
Radio On Your Vacation

By J. L. ARTHUR

A PORTABLE TRANSMITTER AND RECEIVER FOR MOTOR-CYCLE OR CANOE WITH KITE OR TREE AERIAL



For the Vacationist There is Described and Illustrated Herewith a Very Efficient Portable Radio Transmitter and Receiver, This Outfit Being Well Adapted for Use on a Motorcycle or in a Canoe or Launch. It Will Provide Very Satisfactory Results When Used in Conjunction With a Kite Antenna, and for Ordinary Work a Wire Thrown Over a Tree Limb Provides a Serviceable Aerial.

IT makes but little difference where you are in the habit of spending your vacation, and with but few exceptions it has generally been found that taking a radio set with you would be inconvenient either for the reason that your ordinary outfit was too bulky for easy transportation, you did not desire to spend either the time or money for making a portable set which you would not use after the summer, you would be where there would be no power available or there would be no place to string an aerial.

This year, whether you desire to spend the summer in a tent, a summer colony or a hotel, or at the beach or in the mountains where juice is available or not, or even if you decide upon a trip by motorboat, motorcycle, automobile or canoe, there is no need for you being without the added pleasure and convenience which radio brings.

Let us, for a moment or two, forget that important matter of expense, and consider another serious drawback to summer-time operation, namely: the locating of a suitable place and the necessary labor the vacation antenna has generally caused. There has always been some difficulty experienced in planning the location and it not infrequently happens that the natural masts afforded by two pine trees must be abandoned because they are too far from the source of power, or because of some other such reason and the result is generally a slump in spirits since the ideal spot may not be used and an inferior one must be resorted to.

The Kite String Antenna

Where an entirely satisfactory substitute for the permanent antenna is sought it has been found from observations made in the past that a five-foot kite gives the greatest satisfaction. For this reason directions are given for a well-designed kite of any size, taken from the figures of a man who has made kite making and flying a hobby for many years, and who may well be considered one of the best authorities in America. If the suggestions are followed closely no trouble will be experienced in flying the kite or even in making it.

It is best to be sure that the wood used for the sticks is clear spruce, that both upright and horizontal sticks are of the same length, and that the horizontal stick cross the vertical stick at a point one seventh the length of the stick. *NO NAILS* must be driven in or thru to fasten either stick. The proper method of holding them in place is to wrap them securely together by winding or seizing with cord. The vertical stick should be placed so as not to bend and therefore NOT with its flat side near the covering. One cover may be used for varying wind velocities if several sets of sticks are provided, some being heavier than others. The amount of "bowing" necessary in the horizontal stick is equal to the distance it is from the top of the vertical stick, or in other words, equal to one seventh its own length. The bowing on either side of the center of the horizontal stick should be identical. This may be secured by placing the bowed stick on a board so that it will not move and following the inside of the arc it forms with a pencil and then turning the stick over so that the ends are reversed; where it is found that the arcs do not coincide, these sections of the stick should be carefully planed down until the desired

(*Continued on page* 358)

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Resonance Wave Coil Antennae

By J. O. MAUBORGNE, Major, S. C.
and GUY HILL, Capt., S. C.

A NUMBER of articles giving a few meager and, in most cases, inaccurate data, on the resonance wave coil antenna, invented by the authors, have appeared in the scientific and popular journals devoted to radio during the past year. The first announcement of the work of the authors on this subject was contained in a paper read by the Chief Signal Officer of the Army, Major General George O. Squier, before the *National Academy of Sciences* in April, 1920, in which was outlined the first general details of the use of a wave coil, disconnected from a line, from an antenna, and from a ground. Many experiments have been performed since that first announcement of the characteristics and operation of the wave coil as a receiving device, and many patents have been filed, by the authors, both at home and abroad, on this compact type of antenna, for both receiving and transmitting.

Compact types of antenna have always been greatly desired, particularly for use in the military service, in advanced trench areas, and in other places, where a conspicuous antenna would surely draw rifle or cannon fire, and where the exposed position of such an antenna would bring about its early destruction. The need for an antenna which could be easily protected against shell fire was plainly evident from the experience of the last war. In addition, there has been great need felt for compact aerials for use on small boats, on moving vehicles, and in other constricted spaces, such as the sometimes none too extensive garret room, to which the radio amateur has been relegated. All of these difficulties have been solved with the invention of the resonance wave coil antenna.

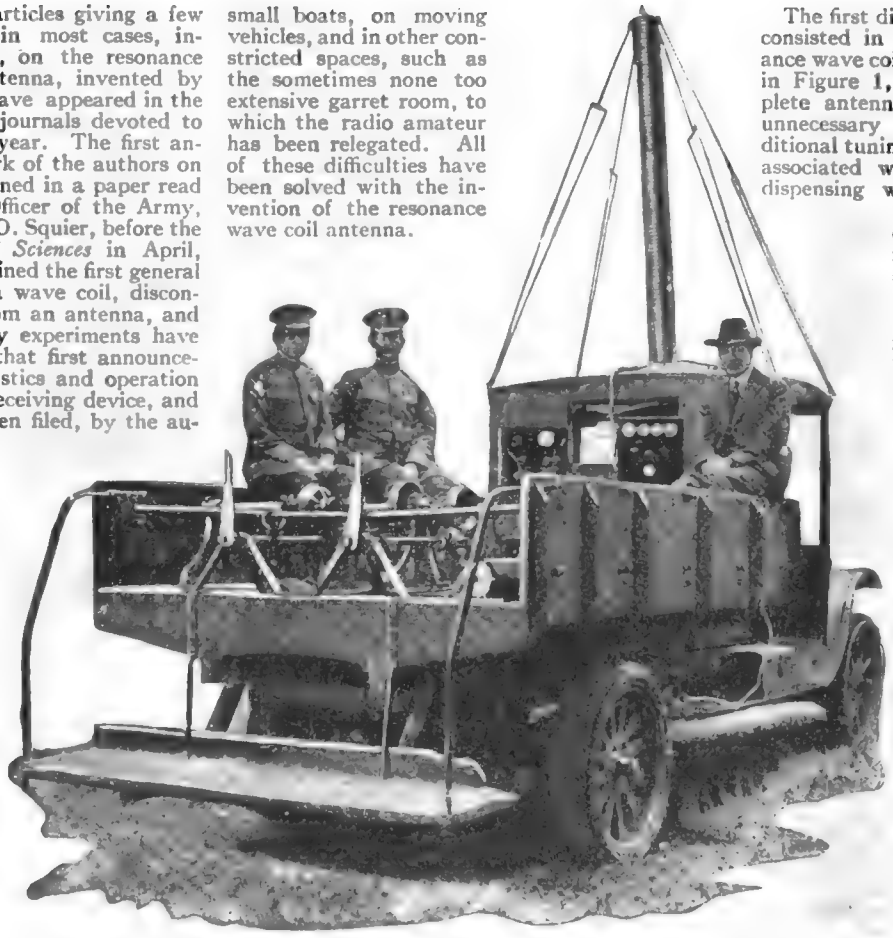

Fig. 7—Tests of a Mauborgne-Hill Resonance Wave Coil Antenna From Signal Corps Truck to Transmitting and Receiving Apparatus Connected to Similar Antenna on Temporary Building. The Transmitter Is One Designed by Dr. Lee De Forest. The Receiving Set Is That Belonging to the SCR-109 Radio Telephone and Telegraph Set Designed by the Signal Corps. Successful Telephone and Telegraph Transmission Without Difficulty Was Obtained at Six Miles from SCR-109 Set on Coil Antenna in Signal Corps Laboratory. Major J. O. Mauborgne, Captain Guy Hill (extreme left), and Dr. Lee De Forest (at right), Shown in Photograph.

The first discovery of the authors consisted in finding that a resonance wave coil alone, such as shown in Figure 1, functions as a complete antenna system, making it unnecessary to employ any additional tuning elements, ordinarily associated with an antenna, and dispensing with any ground, or counterpoise of the ordinary system. The receiving wave coil, shown in the picture, is simply a long tube preferably of good insulating material, uniformly wound with a single layer of fine wire, the total length of the wire, in meters, being from a quarter to a half of the greatest wave length, to which the coil will effectively respond, no other tuning elements being associated with it. Two methods are employed for connecting the wave coil to the receiving apparatus or amplifier. The simplest method consists in the use of a metal band sliding over the insulated wire which forms the coil, the band making electrostatic connection with the wave coil. A second method is employed consisting of the use of a sliding contact which makes direct connection with turns of the coil along a section of the coil from which the insulation has been re-

(*Continued on page* 385)

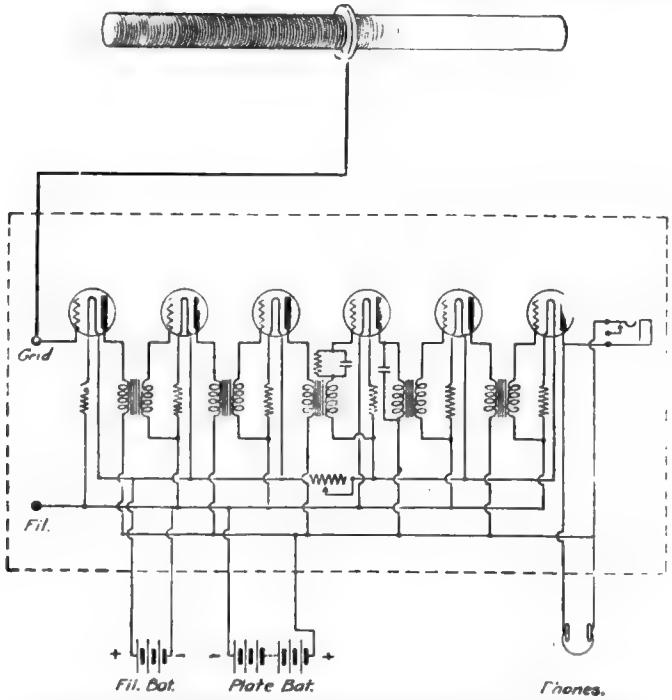

Fig. 2—Hook-Up Using Wave Coil and Multiple Stage Audion Amplifier, No Ground Connection Being Employed.

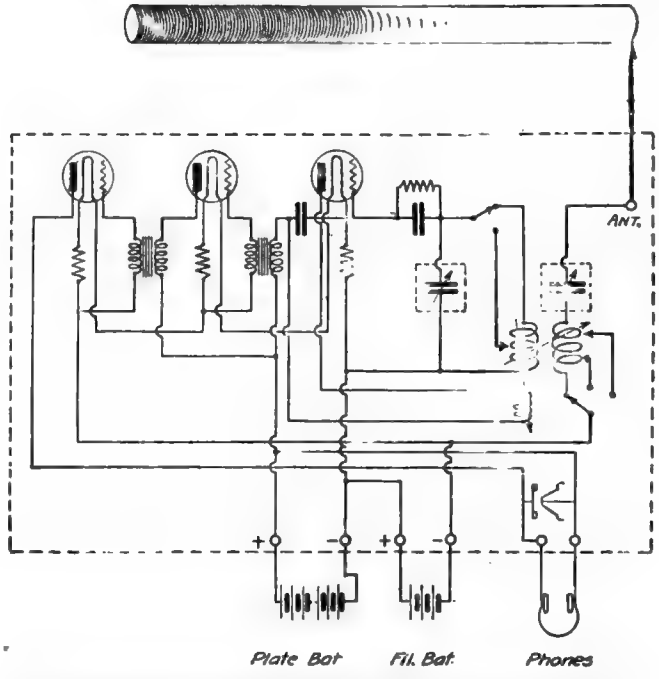

Fig. 4—Later Experiments Brought Out This Circuit Arrangement of Resonance Wave Coil and Amplifier, With Tuning Inductances and Feed-back Circuit.

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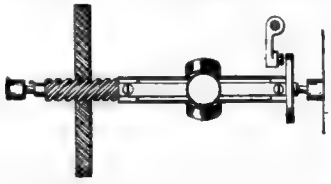
LATEST PATENTS

Drive for Phonograph Governors

(No. 1,365,378. Issued to George T. Cherington.)

Heretofore the seemingly unavoidalbe noise, very objectionable at times,

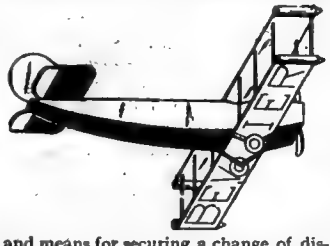


which occurs when the worm and worm wheel, or worm and spiral gear mesh, so as to cause the governor to rotate rapidly, has been often noticed. The inventor of this device claims to have originated a drive which is so noiseless that it cannot be heard even when the hearer is but a few inches from the governor. The improved worm gear is made of leather which is first impregnated with oil and then with grafite. The worm is then cut, and if it appears that the impregnating process has not succeeded in causing the oil and grafite to penetrate sufficiently, and deeper than the teeth of the worm, the process is repeated after the teeth are formed so as to form a gear thoroly charged with oil and grafite.

Airplane Advertising Device

(No. 1,365,219. Issued to Raymond K. Bevier.)

This invention contemplates the combination with an airplane, displaying insignia and advertising matter,



and means for securing a change of display at will. The inventor employs two strips of suitable material, upon which are painted the advertising signs, and which are run between lateral guides secured upon and extending along the sides of the airplane wing. If desired, the entire surface is likewise covered over with a casing of celluloid or other suitable transparent material, to reduce resistance to the motion of the sign, which must of course be made movable. Rotating is done as desired from the rollers on each side and a lever provides for movement of the signs in either direction. Rollers are provided at the ends of both wings to take up the strip of material as it is being paid out, and a similar contrivance is adapted for the upper wing, so that flying upside down will not prevent the onlooker from seeing the sign.

Air-Driven Motor

(No. 1,361,019. Issued to Adolphus Henry Cook.)

Here is an air motor which the inventor claims will give a maximum

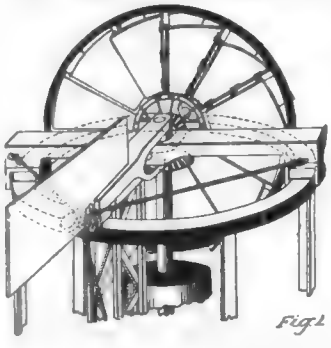


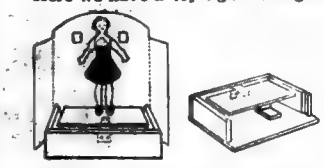
Fig. 1

capacity and an even drive, independent of varying wind pressures. It consists of a circular track upon which the motor may freely revolve. Attached to it are the fan blades pivotly arranged and fitted with tension springs, so that when the wind pressure is high, the fans will assume a position more or less at right angles with the face of the fan, whereas when the wind pressure is low the fans close up more, so that more of the pressure of the wind is utilized. These fans when revolving cause the shaft to turn, which is coupled with a vertical shaft thru the agency of mitre gears. The tail is movable so that it may be swung clear to the right or left, in which position the motor is not in an operating condition.

Toy Dancing Figure

(No. 1,373,932. Issued to Alonzo Horace Allen.)

Here we have a toy figure or figures

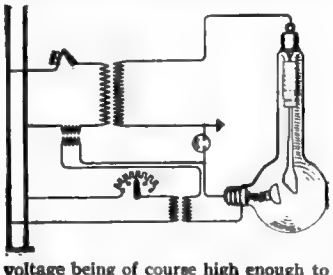


which are suspended over a stage provided with a back screen, the feet or legs of the figure being adjusted so that they barely touch the stage floor. The figure dances realistically and the cause of its dancing does not seem to be established. On closer examination, however, it will be seen that the platform upon which the figure is stationed, is mounted on a flat spring. A lug projects back of the figure so that when the lug or tongue is tapt, the floor of the stage commences to vibrate and these vibratory motions are in turn transmitted to the figure.

X-Ray Apparatus

(No. 1,365,638. Issued to William D. Coolidge.)

Mr. Coolidge, undoubtedly the foremost X-ray specialist, comes forward with another invention, particularly meant for those who have had very little training in the operation of X-ray apparatus. In this patent an X-ray tube is connected directly to the secondary winding of the transformer, the

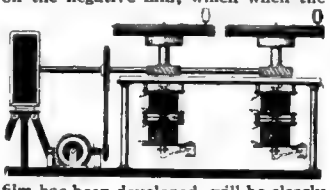


voltage being of course high enough to permit its use in X-ray work. To avoid damage to the apparatus by a momentary high voltage which would occur were the circuit closed on the peak of a primary current wave, a starting resistance is employed in the primary circuit. The X-ray tube is so proportioned that the operating current is determined largely by the X-ray tube, instead of being dependent mainly on the cathode temperature as in X-ray tubes now in use.

Synchronized Recording and Reproducing Apparatus for Visual and Audible Actions

(No. 1,374,913. Issued to Charles W. Ebeling.)

In various synchronizing mechanisms it has been found desirable to form openings in the film to permit of circuit closers being opened in the circuit, the film thus acting as an insulator between the contacts. This is quite an old idea. The inventor has, therefore, designed a means whereby the camera man, while operating the film to make the negative, is able at the proper time, mechanically to close the circuit thru a switch, which will cause an indication to be placed at the proper point on the negative film, which when the

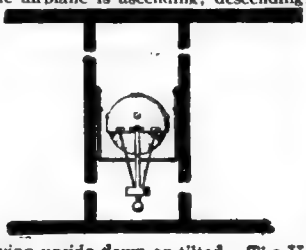


film has been developed, will be clearly observable, so that the positive film developed therefrom shows at the proper point, an indication in the form of a white or black mark, rendering it an easy matter to perforate the film or attach a projection thereto without measuring as is the present custom. It has been found that, when using this apparatus which has incidentally an electro-magnet attached to its base to automatically throw gears into position in relation to a moving drive rod, it is possible to have the speaking record made first, and then the actor or actors may move in synchronism with the sound.

Aero Inclinometer

(No. 1,365,233. Issued to Harry J. Earle.)

This is a device which is for use on airplanes to enable the operator to determine at a glance the exact angle at which the machine is in flight, whether the airplane is ascending, descending,

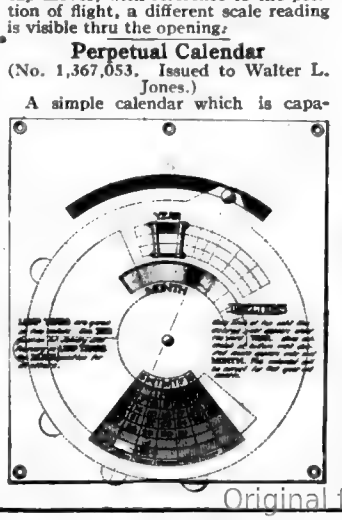


flying upside down or tilted. The U-shaped frame is mounted rigidly in a perpendicular position upon the airplane, within this is a semi-spherical cap or hood which has provided in the extreme top point a central peep-opening having a transparent covering or section, such as glass, and arranged within this hood are friction bearings to allow for the free movement of this hood with relation to a spherical body contained within it. Upon this spherical body are placed the markings to indicate the number of degrees of tilt, as for instance, L 50 U indicates a tilt of 50° between left and up for the particular turn being made at the time it will therefore be noted that as the cap moves, with reference to the position of flight, a different scale reading is visible thru the opening.

Perpetual Calendar

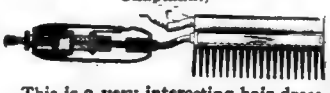
(No. 1,367,053. Issued to Walter L. Jones.)

A simple calendar which is capable of being easily and quickly adjusted to adapt it for presenting the exact calendar for any month in the year, past, present or future, which may be found in a rapid and accurate manner. The desired information may be ascertained by direct reading, and without the need of a key, table or calculations; the week day designation remains stationary. Essentially it consists of two movable parts which are lined with segmental slot-ways in the face member. One of these the month card exposes to view the determined month, exactly in accordance with the days printed on the face. This comprises a series of seven radial sectors or spaces in concentric alignment with the rows of year and day numbers. Some of the month spaces have several of the months indicated thereon. one has three different months indicated and the space having February designated has the numeral 28 in black, and Feb. 29 printed in red, for designating the leap year number of days in February. The year card has a large segmental opening, and the difference in straight and leap years is also noted by a change in color.



Hair-Dressing Device

(No. 1,362,780. Issued to William C. Chapman.)

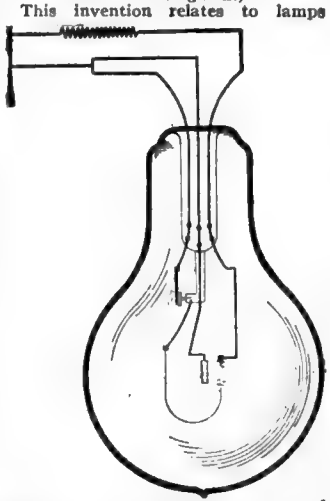


This is a very interesting hair-dressing device which is capable of performing a variety of functions. It comprises briefly a tubular comb carried on a handle, within which handle there is a receptacle for grease, such as vaseline. This can be forced into the tubular passages of the comb and out thru apertures at the roots of the teeth. The comb is further provided with a heater, by which it may be heated, and provision is made for attaching the grease receptacle in the handle to a tank, so that water, hot or cold, can be applied to the comb instead of grease, or after the grease has been exhausted.

Arc Incandescent Lamp

(No. 1,374,647. Issued to Edward Alfred Gimingham.)

This invention relates to lamps



which have substantially the outward appearance of the ordinary incandescent bulb. Up to the present time, these lamps have had arrangements, whereby the tungsten pole-pieces have been moved apart by mecanisms within the globe which made it quite impossible to highly exhaust the lamp. According to the present type a heater serves to ionize the gas and also to carry one pole of the arc and when ionization is completed, the arc is formed between an electrode in parallel with one end of the heater and a point on the heater or electrode, the latter being in parallel with the other end of the heater.

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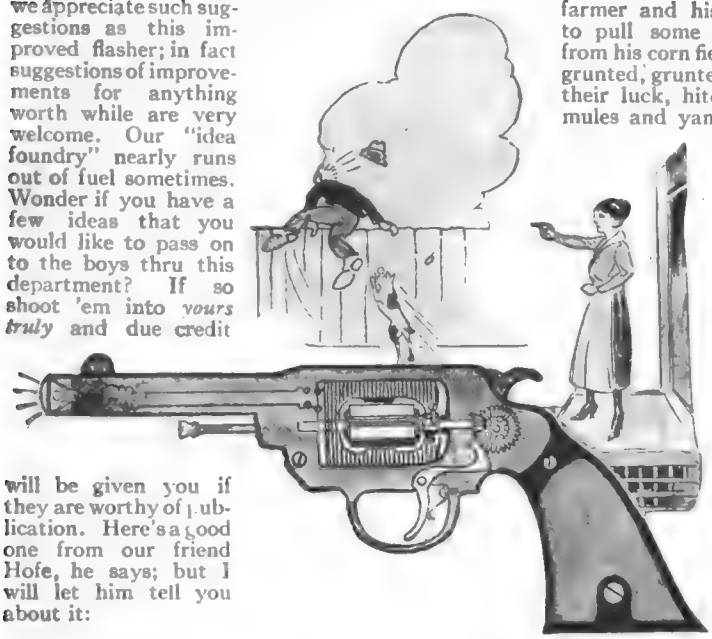
What to Invent

By JAY G. HOBSON

ONE of our valued readers has joined the ranks of "Ye Close Observers," and has written the writer about a very good improvement. This is the kind of interest we like to see—we appreciate such suggestions as this improved flasher; in fact suggestions of improvements for anything worth while are very welcome. Our "idea foundry" nearly runs out of fuel sometimes. Wonder if you have a few ideas that you would like to pass on to the boys thru this department? If so shoot 'em into *yours truly* and due credit will be given you if they are worthy of publication. Here's a good one from our friend Hofe, he says; but I will let him tell you about it:



A Reader Has Suggested This Idea for a "Flashlight Revolver" — Why Not Make It Resemble An Actual Revolver, Which Could Then Be Used to Frighten Thieves With? The Trigger, When Pulled, Drives the Miniature Dynamo Supplying Current to the Lamp.

"Dear Sir:

"Glance at the illustration of a hand generated flashlight on page ninety-four of May 'Science and Invention' and you will see why we do not want this model. The bother of that handle catching in the pocket would soon cause it to be discarded as a nuisance. That is only one defect noticed. Why not a revolver model? In this case there is reason for such a model.

"Have the lamp in the muzzle—the trigger will spin a generator located where the usual cylinder is. Have compartment for an extra lamp. Copy the revolver exactly, so it can be used for a 'bluff.' Arrange lamp to slide back in the barrel for a pencil-beam, or to slide to muzzle for fan-ray—sure they will sell!

"FRED HOFE."
Phila, Pa.

Chemical Stump Puller

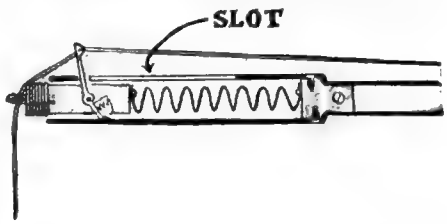
The other day a friend and I went fishing in Indian Creek; that is we went down to Indian Creek to catch some fish, but that's not saying we had much luck; altho we honestly did land some about this long,—and if you don't believe us just look in our back yard the next time you pass and you'll see the evidence—*caput mortuum*.

Well, what I started to say was, that we went fishing in Indian Creek which is hidden away in the willows and sycamores that thrive along the zig-zaggy bank. Before reaching the "Ole Fishin' Hole" we past a farmer and his hired-hand trying to pull some long-rooted stumps from his corn field. They chopt and grunted, grunted and pulled, cursed their luck, hitched their team of mules and yanked some more, but the old stump remained in the ground as persistent as our rent collector. They were about ready to admit their defeat when a Dutchy looking individual arrived on the scene speaking in broken English. He proved to be a recent arrival from Germany and was employed by the farmer. Seeing their difficulty with the stump he told them how they cleared fields of stumps in Germany.

Recently Two Yankee Farmers Were Pulling, or Trying to Pull Out Stumps and Small Trees, When a German Farm-Hand Came Along and Told Them How They Disintegrated Such Roots in the Old Country by Pouring Some Chemical on Them. A Good Hint for American Chemists.

As I understood him, he explained that they first bored deep holes in the roots and the stump proper, then they injected some secret chemical or liquid dissolvent that softened the wood, which made it very easy to pull from the ground. I asked him what the chemical was composed of but he said: "Das, I dunno."

Now it appears to me that some of our American chemists could find a chemical that would serve this great purpose. There is no question about the big money that could be derived from the sale of same, as well as the great good it would do in saving lives lost from the use of blasting powder and the like. The demand is only waiting for the supply—here's your chance.



A Trigger Device Like This Placed on a Fishing Rod Will Cause the Line and Hook to Be Jerked Upward Several Inches When the Fish Nibbles at the Baited Hook, Thus Hooking Him Every Time.

Automatic Fishing Pole

I didn't quite finish telling you what happened when we went fishing the other day.

Well, I'll make it short and snappy—I was sitting on the grassy-bank, (Creek-bank ahem!) it was about two in the afternoon. The Sun was sleepy hot. I was hot and sleepy for the fish weren't at all sociable. But every once in a while I'd get a nibble—the old cork would dive up and down—I'd jerk my pole quick-like, but hardly quick enough to secure the hook in the fish's gill—consequently Mr. Fish would giggle at my quibble and steal my fine big worm.

But I caught a good idea for an improve fishing pole. With this new arrangement a fellow can go to sleep if he wants to and still catch a good batch. My idea consists of a small metal cylinder with a piston inside and retained movably therein by a coiled spring. In the middle of this metal piston is arranged a small trigger device that has a small eye or hole in the end for the tackle to go thru. When the user wishes to set same, he pulls out the piston, knots the tackle back of the trigger device, which holds the piston in a set position. When the fish pulls the hook the trigger releases the piston which flies back into the tube, thereby securing the hook in the fish.

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Some Curious Lamp Facts

By GORDON D. ROBINSON*

ACCORDING to the experience of the General Electric Company about ten per cent of a tungsten filament evaporates before the filament burns out. It is also known that this rate of evaporation of the filament and the rate of emission of electrons from the filament both vary in the same manner, as the temperature of the filament changes. From this we have the relation that the probable life of the filament of a vacuum tube varies inversely as the maximum plate current.

As an example, consider two vacuum tubes with similar filaments. If the first one is operated at a filament temperature which gives a saturation current of one milliampere and the other filament is operated at a temperature which gives a saturation current of ten milliamperes, the first tube should burn ten times as long as the second one. If we are using these two tubes as high frequency generators, each with the same value of plate voltage, the power that we can get out varies approximately as the plate current. From this we see that the second tube in the example above should give about ten times as much power output as the first one. By giving ten times the output for only one tenth of the time, the total number of watthours of output obtained will be the same as for the tube with the cooler filament. This leads to the conclusion that the maximum possible watthour output of a certain vacuum tube is roughly a definite amount, which (within reasonable limits) does not vary with the temperature at which the filament is operated.

We might conclude from the preceding that when we purchase a tube for a CW transmitter we have purchased a certain number of kilowatt hours of high frequency energy for our antenna. This condition applies, however, only to the case when it is specified that a certain definite value of plate voltage is to be used. Up to the point where the tube begins to show signs of distress (from blue glow, failure of insulation, or overheating of the plate) this number of kilowatt hours increases directly with the plate voltage used.

From this last we get the valuable hint that for power tubes we should always use the highest plate voltage on which the tube can safely be operated.

*Assistant Professor, Dept. of Elect. Eng. and Physics, U. S. Naval Academy.

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Scientific Humor

Thanks for the Tip.—DUBB: "Why do you always question patients so closely about what they eat? Does the information you get help you to diagnose their cases?"

DOCTOR: "Oh, No! But by doing so I am enabled to guess what their station in life is, and how much in fees I can probably get out of them."—*Joe Radomsky.*

Tie the Bull Outside.—"Here, boy," said the man to the boy who was helping him to drive a bunch of cattle, "hold this bull a minute, will you?"

"No," answered the boy, "I don't mind bein' a director in this company, but I'm darned if I want to be a stockholder."

—*Joe Radomsky.*

Suicide Specialists.—"Scientific Salesmanship," said Irving Fletcher, the brilliant raconteur at a Sphinx Club dinner, "may be carried too far. "In a hardware shop the other day I was buying a wrench for my car when a morbid-looking chap came in and said:

"Quarter's worth of Carbolic Acid!"

The Scientific Salesman smiled and shook his head regretfully.

"This is a hardware shop, not a drug store," he cooed, "but is there nothing we can do for you in the razor, revolver or hemp rope line?"—*No Name.*

A Sign of the Times.—TOURIST: "A dangerous drop off here if someone drives recklessly. Wonder they wouldn't put up a warning."

GUIDE: "They had one up for over a year, but no one was ever hurt, so they took it down."—*E. Z. Hill.*

Inside or Outside.—CUSTOMER TO BARBER: "I wish I could get something for my head, but I've tried about everything, and nothing seems to do it any good."

BARBER: "Ever try a Vacuum Cleaner?"

—*Chet Clearwater.*

A Second Betelgeuze.—TEACHER (in Girls' College): "Name the star which recently was measured and found to be of enormous size."

YOUNG MISS: "Fatty Arbuckle."

—*Ernest T. May.*

A Tale of a Dog-gone Watch.—Willie's father had just bought him a dog and he took Johnnie over to see it. When they came to it, it was whirling around in a frantic effort to catch its tail.

"What kind of a dog is it?" asked Johnnie.

"A watch dog," answered Willie.

"Oh, I see," remarked Johnnie, "I suppose he's winding himself up."—*Arnold Eck.*

So Does a Carpet-runner.—1ST MAN: "I think bookkeeping is a very healthy position."

2ND MAN: "How come?"

1ST MAN: "You get lots of exercise running up and down the columns."

—*Wm. L. Greeway.*

First Prize $3.00

Boy! Page Mr. Volstead.—"S'no use!" sighed the Electric Bulb to a Prohibition Officer.

"No matter how hard I 'resist' the 'juice,' I'm always bound to get all 'lit-up'."—*Joseph Byrne.*

A Question for Tee-Totalers.—A question that has baffled scientists: If tea leaves has coffee grounds for divorce?

—*J. Dalstrom.*

Ah! Time Left No Mark Upon Its Face—SCOUT: "Shall I mark time with my feet?"

SCOUTMASTER: "Did you ever hear of marking time with your hands?"

SCOUT: "Yes, Sir! Clocks do it."

—*Arnold Eck.*

WE receive daily from one to two hundred contributions to this department. Of these only one or two are available. We desire to publish only scientific humor and all contributions should be original if possible. Do not copy jokes from old books or other publications as they have little or no chance here. By scientific humor we mean only such jokes as contain something of a scientific nature. Note our prize winners. Write each joke on a separate sheet and sign your name and address to it. Write only on one side of sheet. No letters acknowledged unless postage is included.

All jokes publisht here are paid for at the rate of one dollar each, besides the first prize of three dollars for the best joke submitted each month. In the event that two people send in the same joke so as to "tie" for the prize, then the sum of three dollars in cash will be paid to each one.

The Long and Short of it.—A motor being out of order in a small factory, electricians were repairing it. The owner's father, a very old man was sitting on a chair nearby.

"What is the matter?" asked the old man.

"Short-circuit," was the reply.

"Nothing of the kind," said the old man, "the circuit is long enough; look at the wires running from the wall clear to the machine."—*B. A. Lowenthal.*

Or a Fireproof Suit.—"Say, Smith, how do you like that cigar I gave you? If you smoke 1,000 of them and save the bands they give you a talking machine."

"Huh, if I smoked 1,000 of them, I wouldn't want a talking machine. I'd want a harp."—*Edward J. Rife.*

Of Primary Importance.—PROPRIETOR: "Money is a secondary matter to me."

ELECTRICIAN: What's primary then?"

PROPRIETOR: "My wife."

ELECTRICIAN: "How's that?"

PROPRIETOR: "She spends all my secondary."—*Ray Parker.*

Then There Was No Little "Fairy" in Their Home.—HE SAID: "Let me hold your Palmolive."

SHE SAID: "Not on your Lifebuoy."

—*Joe Radomsky.*

(I wonder was he Olive's buoy. —*Printer's Devil*).

Showing Off.—SHY MISS: "I envy her nonchalant and indifferent air. She doesn't seem a bit self-conscious among a crowd.

MISS WISE: "Well, she used to be a window demonstrator."—*E. Z. Hill.*

Not to Mention a Shock-Proof Rolling Pin.—A few suggestions to aspirants in the field of invention:

Absolutely noiseless door hinges and locks would please many young men.

A non-skid soap would be a popular article.

The vast majority of men would appreciate a device guaranteed to eliminate such words as, "massage," "singe," "tonic," etc., from a barber's vocabulary.

A dancing slipper, treated so as to make the adhesion of chewing gum impossible, would find a ready sale.

An adjustable solitaire ring, fitting any sized finger, would obviate the necessity of many purchases and resales.

Restaurants, wishing to be known as quiet, would furnish a large market for noiseless soup spoons.—*F. H. Hill.*

It Has Second Place in Hell.—What is,

"The beginning of eternity,
The end of time and space.
The beginning of each and every end
And the end of every place?"

Ans.:—The letter "e."—*Arthur Buesing.*

He Couldn't Bridge the Gap.—"A good many ladies were disappointed this afternoon."

"How was that?"

"The guest was spoken of as a bridge expert, and he turned out to be nothing but a famous engineer."—*Ward Stanton.*

"Music Hath No Charms" in This Case.—TEACHER: "John, name an organ of the body."

JOHN: "The teeth."

TEACHER: "What kind of an organ is it?"

JOHN: "A grind organ, Ma'm." — *No Name.*

And Rust On It's Hands.—MACK: "Al, what time is it?"

AL: "What is the matter with your ticker?"

MACK: "It's got dandruff on the hair spring."—*No Name.*

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THE ORACLE

The "Oracle" is for the sole benefit of all scientific experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

What a Transformer Will and Will Not Do

(1122) Tom M. Crichton, Sterling, Col., inquires:

Q. 1. Referring to the January, 1921, number, pages 980-981, illustrating the Long Lake Power station, and to your descriptive article, may I beg your assistance?

The battery of generators at the falls develops a current of 4000 volts. This current actuates a *step-up* transformer, which generates an induced current of 100,000 volts.

Does the voltage of this induced current measure the same electro-motive energy as the voltage in the 4000 volt current generated by the battery of dynamos? That is, has the transformer multiplied the original energy by twenty-five?

What per cent (approximately) of this current of high voltage is consumed at *the tap* which supplies the *step-down* transformer to actuate the 2300 volt motor driving the D.C. dynamo? Or is it entirely consumed?

Would it be practicable for a farmer, having a small independent electric plant, to increase his available horse-power by the installation of a transformer in his circuit?

A. 1. The transformer never multiplies the electrical energy passing thru it when this energy is exprest in watts, horse-power or kilowatts. All that a transformer does is to either reduce or raise the voltage of the circuit. If the voltage is multiplied ten times by a certain transformer, for example, the current in amperes in the secondary circuit is reduced to 1/10th of that passing thru the primary circuit, assuming that there was no loss. There will inevitably be a loss.

We do not quite understand your second inquiry with reference to the percentage of current or rather energy consumed at the tap which supplies the step-down transformer actuating the 2300 volt motor driving the direct current dynamo. We presume you mean the percentage of loss occasioned in operating the transformer as well as the dynamo, and just off hand we do not know what this exact loss is, but in any case it is very low as these machines are large affairs and therefore, very efficient electrically. The transformers, motors and dynamos of this large type usually operate at an efficiency of 95 to 98%, depending upon the kilowatts rating—the higher the rating and bigger the machine, the higher the percentage of efficiency, 98.5 to 99% being about the maximum for large transformers. The efficiency of a group of apparatus, comprising the transformer rated at 98% efficiency, the motor with an efficiency of say 90% and the dynamo at 90%, would be determined by multiplying the three efficiency figures together, resulting in 79% efficiency for this group of three apparatus.

You fail to realize that the volt is a unit of potential difference, and not a unit of current, or of power.

A Mysterious Clock

(1123) Stanley Trier, Maywood, Ill., tells us of a clock he saw which (so the advertisement reads) worked satisfactorily because of the fact that the earth rotated. He asks:

Q. 1. Is such a clock possible?

A. 1. The editor well remembers having seen perpetually running clocks but such clocks never utilized the wonderful powers possest by the earth.

If you will examine the clock you describe in your letter, carefully, you will note that there is in each of the weights at the projection from the hands, a little clock motor resembling that in a fine watch, and if the authorities do not agree with this, we would advise that you place a powerful bar magnet near the weight arms so that its effect will be centered upon the hairspring in its delicate mechanism, causing it to stop; and the cessation of its movement will not be due to the earth stopping its motion, you can rest assured.

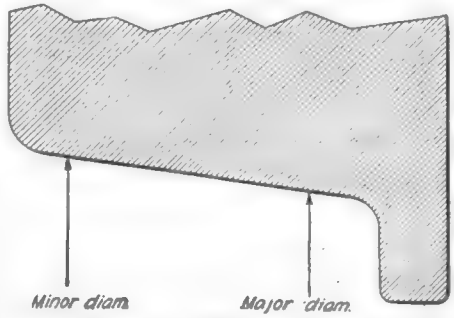
How Can Wheels Round Curves

(1124) C. W. Holcombe, Atlanta, Ga., inquires of this department:

Q. 1. How do railroad car wheels get around curves when both wheels are fastened to the axle, the outer rail being the longer path?

A. 1. Answering your question as to how it is that the outside wheels of a railroad car going along a curve can travel faster than the inner wheels, would say that this is taken care of by the fact that the faces or rims of the wheels are curved in a very careful and mathematically determined manner, as shown below, with the consequence that when the car swings out in rounding a curve, the outer wheels rotate on their major diameters or periferies, while the inner wheels rotate on their minor diameters. Some slippage also accounts for the facts in the case.

For example, suppose that the major circumference of a given wheel was 12 feet, and the minor circumference 11.25 feet. It is clear that in making 10 revolutions of the axle, the outer wheel, in rounding a curve, will travel farther than the inner wheel, in the ratio of about 4 to 3.75 or 6¼ per cent farther.



The Diagram Above Shows How Car Wheels, Which Rigidly Fastened On to a Common Axle, Manage to Pass Around Curves in the Track Without Causing the Outer Wheel to Slip Excessively. As the Car Swings Out, the Outer Wheels Rotate on Their Larger Circumferences, While the Inner Wheels Rotate on Their Smaller Circumferences, the Tread Being Coned.

Plating Mirrors

(1125) Raymond R. Rose, Colome, S. Dak., asks:

Q. 1. Please give instructions on plating headlight reflectors and also how to make mirrors.

A. 1. You can probably coat your reflectors with silver without the aid of a battery, by applying a paste made with 2 parts of freshly precipitated silver chloride and 3 parts of potassium bitartrate.

The surface to which the paste is to be applied must first be thoroly cleaned. A little dilute nitric acid will remove rust, etc., and grease is taken off by immersion for some time in a hot solution of caustic soda. After this immersion the article must not be touched with the fingers. The alkali is removed by thoro rinsing with water.

To the metal so prepared, the silvering paste is applied with a soft cork. When a sufficient deposit has been made, the article should be washed in hot water, and it may be conveniently dried by shaking with saw dust.

The silver chloride can be prepared by dissolving crystallized silver nitrate in distilled water, say 1 part in 10, and adding to the solution a solution of sodium chloride (common salt) of similar strength, continuing the addition until no more precipitate is formed. The precipitate is then washed to free it from any excess of the precipitant, by filtering and washing on the filter.

Electro Plating Solution

A simple formula for a silver plating solution is prepared as follows:

Water	1 gal.
Silver chloride	3 oz.
Potassium or sodium cyanide	8 oz.

The sodium cyanide is dissolved in warm water. To this solution is added the silver chloride which has been reduced to a paste with water.

Anodes of pure silver are usually employed. The purity of the metal influences the deposit and only the purest silver should, therefore, be used for anodes. While it is not absolutely essential, the anode will function better if it be annealed prior to placing in the bath.

The required voltage is exceedingly low for silver plating, ½ to 1 being sufficient. The average current density is approximately 2½ amperes per square foot of surface plated.

For Mirrors

At the present time it is customary to make mirrors by depositing metallic silver on the glass. The latter is first made chemically clean by washing or scrubbing with an alkaline liquid, then rinsing with distilled water. Any spot or stain, even a momentary touch of a person's finger, is liable to interfere with the uniformity of the deposition of the silver and to be the cause of an imperfect mirror. After the glass has been cleaned and drained it is to be laid down flat and over it is floated a solution of the silver salt, usually the nitrate with some ammonia added. When the glass is completely wetted, a reducing substance in aqueous solution is added. Various reducing agents are used, such as Rochelle salt, glucose, formaldehyde, etc.

1. Edel's process:

Solution A.	
Silver nitrate	437 grains
Distilled water	
Ammonia water, each	Sufficient

Dissolve the silver salt in 8 fluid-ounces of distilled water and add ammonia water gradually until the brown precipitate that is thrown down at first is just dissolved, being careful not to add too much ammonia. To make sure that too much ammonia has not been used, drop into the liquid a crystal of silver nitrate and shake; if the solution becomes turbid, no excess of ammonia has been used, and if it does not, more silver must be added till it does become turbid. Then filter the liquid thru a double paper filter, returning the first portion of the filtrate to the filter until the liquid runs thru clear, and add enough distilled water thru the filter to make the filtrate measure 16 fluid-ounces. Put this in a clean bottle, cork well, and keep in a cool, dark place over night.

Solution B.	
Rochelle salt, chemically pure	dr. 2
Silver nitrate	gr. 10
Distilled water, to make	fl. oz. 16

Dissolve the salt in 10 fluid-ounces of water, and heat the solution to boiling in a porcelain dish. Then add 10 grains of silver nitrate, stir with a glass rod, and boil the liquid gently for 10 to 15 minutes or until it becomes of a gray color. Filter this thru paper until clear, and add enough distilled water thru the filter to make 16 fluid-ounces of liquid. Put this into a clean bottle, cork well, and place away for 5 to 6 hours.

When the preparation is wanted for use, mix

Solution A	fl.-oz. 1
Solution B	fl.-oz. 1
Distilled water	fl.-oz. 4

Immediately pour this mixture over the glass, which has previously been cleaned as described above, and leveled. Then allow to stand until the solution has deposited its silver, about one hour being required. Then decant the excess of liquid, rinse off with clear water, and stand the glass on edge to dry. Lastly apply a protective coating of asphaltum varnish, using a soft camel brush to avoid scratching the silver. We are indebted for the mirror plating process to the STANDARD FORMULARY.

Electric Oil Locater

(1126) John Johnston, Jr., Escondido, Calif., asks:

Q. 1. What information have you or can you give me regarding mechanical device for locating oil deposits, either electrical or magnetic plumb-bob? Have seen some of the latter actually in use and understand there are some being used in Texas that are considered reliable.

A. 1. Your recent communication at hand requesting our advice on mechanical device for locating ore deposits.

Magnetic plumb-bobs are not successful, and devices of this nature have been condemned as fraudulent, the use of United States mails being denied them; definite data of which we can furnish should you so desire.

The electrical devices however, which have proven of great success are the Mansfield's oil and water locater, an advertisement appears in the classified column of our magazine. This is a gold medal winner, has been investigated by British engineers and is guaranteed to be the most reliable yet originated.

We would suggest that you write to them for more definite information. The Hughes Balance has also been used with some success, but is employed generally for locating ore beds.

Making Radium Paint

(1127) James H. Jameson, Jersey City, N. J., inquires:

Q. 1. How is radium paint made?

A. 1. Radium paint is made by mixing a minute quantity of radium bromide with calcium sulfid. Mix these with some turpentine as a thinner, and a little adhesive material such as varnish to make it stick.

A complete apparatus for performing all this work and instructions is supplied by one of the large radium chemical companies.

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Not a cent in advance. No deposit of any kind. No obligation to buy. The coupon is all you need send. The Oliver comes to you at our risk for five days' free trial in your own home. Decide for yourself whether you want to buy or not. If you don't want to keep the Oliver, simply send it back at our expense. Then we even refund the outgoing transportation charges—so you can't lose a penny. If you do agree that it is the finest typewriter, regardless of price, and want to keep it, take a year and a half to pay at the easy rate of only $4 a month.

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I have had this address "P. O. Box 882" over twelve years.

The Electrical Home of To-Day

(*Continued from page* 318)

to a nest of sockets on the edge of the table, being now concealed within one of the legs or the pedestal of the table. Short flexible wires then lead from the various table devices to plug receptacles mounted on the edge of the table. The usual equipment includes an electric coffee urn, a toaster, a grill, and some people have several other electrically heated utensils, which are kept on a serving table or sideboard at the side of the room—only a few of these being placed on the dining table, as required for each meal. One of the sockets on the table may be used for plugging in the vacuum cleaner, but in many cases convenient receptacles are placed in the base-board in each room for vacuum cleaner service.

We have mentioned before that electric fans are a great boon in warm weather, for circulating air thruout the house, and making life a little more bearable during this season, and one good thing about fan motors is that they are very efficient in their current consumption and do not consume any more energy than a 50 watt lamp. The oscillating fans which swing to and fro are of course the best in many instances, and a small exhaust fan mounted in the upper part of a kitchen window or in the wall is often a god-send.

The average house is usually arranged with a laundry, even tho of small size, and one will be surprised at the increased efficiency in this department of the household, when an electric ironing machine or mangle is installed, as well as an electric iron, preferably not less than 6 pounds, and of course an electric washing machine.

Out in the garage, and it is quite the caper nowadays to build these as an integral part of the house even in some of the finest residences, we find several important uses for electricity. Where alternating current is supplied a small rectifier will be found advisable for charging the ignition battery now and then, when it runs low, and electric vulcanizing devices both for repairing inner tubes as well as the heavier shoes or tires may be included. And now we find available small comprest air pumping outfits, driven by an electric motor, which will soon prove their worth in inflating tires. All this will prove very desirable. An electrical tire pump will give the owner his own "free air."

The Movies of the Future

(*Continued from page* 307)

sticks of wood in the open fire-place should crackle, the sea should roar; and if Niagara or the Great Zambesi Falls were on the screen, the impressive thunder of the water should greet our ears.

It is perfectly evident that for the production of these sounds quite elaborate collections of instruments would be required.

A very obvious defect in the theater of today is, that the one voice of each actor is addrest to people a hundred feet from him or to those in the seats directly in front of the stage and under the foot-lights. In the future movie theater, perfect headphones will be supplied, so that those at the most distant corner will hear exactly the same as if they were close to the screen.

Of course color is contemplated in Dr. Hubbard's prediction. The movie theaters of today will in the future rank only as ttle theaters, in which films can be tried t on smaller audiences, to be finally proced in great circular auditoriums, exly such as described by Mr. H. Gernsk in a recent issue of *Science and Inion* and there illustrated in detail.

en such minor advances as electric et vendors, electric lamps for designatthe location of vacant seats, really imant details, all of these entered into Dr. obard's description. Stereoscopic effects in the future. As an example of what may expect, Dr. Hubbard reminded audience that his most extreme ideas the color reproducing stereoscopic ie camera were anticipated, when mad over his eyes, for they are self-cting, self-focusing, and self-cleaning. Every three seconds about, the eye lid, with its moist interior, sweeps over the lens to keep it immaculately clean. The iris gives an adjustable diafram, and the retina receives the light waves, and telegraphs them to the brain. Dr. Hubbard hopes that the motion-picture engineer will sooner or later perfect a motion-picture camera according to the specifications of Mother Nature.

The Public Libraries will be used to circulate films as they now circulate books; the film reels will be loaned to private individuals for use in their home cameras. Highly specialized films on every conceivable topic, Dr. Hubbard says, will be put into circulation.

We are only beginning to take advantage of the educational value of the film. Movie cameras are now being purchased by the schools and moving pictures will be used as modes of instruction. As they accumulate they will acquire a historical value. Present day films of Niagara Falls will tell future generations what they have lost in taking the water of the Great Lakes for power purposes, leaving the great falls void of nutriment. The railroad express engine of today, filmed in full motion, will be a great contrast to the future electric locomotives, and many feel that the trolley car awaits an early extinction, so that movie films of our busy streets, will tell a strange story to our great-grandchildren.

In his paper Dr. Hubbard seems to give free scope to his imagination, but his apparently wildest predictions are all well within the range of probability; so much so, that the future will probably see much more wonderful things in the movie world, than those predicted by the most imaginative scientist.

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SOLDERS FOR ALUMINUM

The U. S. Bureau of Standards has completed a series of tests of aluminum solders. The results will be contained in "Circular 78," entitled "Solders for Aluminum. We quote from the words of the editor of the Bureau of Standards: "In spite of claims made by those interested, no solder for aluminum has yet been found, which will withstand the corrosion test, although the fused zinc chloride solders withstand corrosion for the greatest length of time."

Do Compound Eyes Magnify?

By WILLIAM M. BUTTERFIELD

(*Continued from page* 316)

the power of reducing any reflected object to a very tiny portion of its actual size, thus further increasing their mystery.

When the compound eyes of the bee are thus prepared, they are found to be composed of transparent hexagonal facets (as shown in our drawing), each acting in a commonplace, mechanical fashion reducing the size of the image and obtaining a flat, clear reflection. The mechanical aspect might be doubted, if it were not for the *multiplying glass* of the optician which produces the same results when used in the manner described (see drawings). The glass lens with its faces ground in hexagonal shape reduces the image of an object and obtains flat, multi-repeated reflections just as seen in the faces of the bees' compound eyes, proving without doubt that the bees' visual apparatus *extends the range of vision in all directions by the aid of such hexagonal facets or eyes.*

With man's ordinary perception of vision, he is likely to imagine that the thousands of reflections, shown in an exhibit of this kind, are conveyed somehow to the optic nerve in a kind of concentrated panoramic picture. Yet this is not the case, for this lens organ is considerably removed from the bulbous extremities, or retina of the various eyes; hence it is merely a combination of visual sensations that reach and pass thru this point, not a picture in any sense whatever. The form of sight, very much like our own, is given to the bee by other simple eyes, called cornet eyes, and is used to guide most of their movements just as we use ours. Recent investigations have clearly demonstrated the important use and purpose of these simple eyes. Compound eyes are not therefore useful to an insect or crustacean in the sense of increasing its capacity to observe surrounding objects, but *rather as a highly organized apparatus for giving a visionary warning sense*, substantially similar to the use of the senses of smell, hearing and touch in animals.

Because of the reducing power of compound eyes, it is very probable that the distance at which objects can be seen is not great, *perhaps not over one foot.* It has been estimated that the Woolworth Building in New York City, reflected in the ocelli of a bee's eye five hundred feet away, would be shown as a mere dot no larger than the point of a fine cambric needle.

It is true that the mass of immovable eyes with their various cones, fibers and nerve connections, also in a sense immovable, are so placed that impressions received by all are centrally mast in a kind of mosaic optic sensation (see Fig. 1), yet there is ample proof that *it is not a pictorial sensation.* We defy the most intelligent advocate of the picture theory to comprehend in its entirety a picture that includes in one unbroken glance the ground that he stands on, the sky above him as well as the landscape on every side, for try as he may, he can only comprehend this panorama by concentrating his mind on the various objects forming it, one at a time, *we cannot see any extensive composite picture at a glance.*

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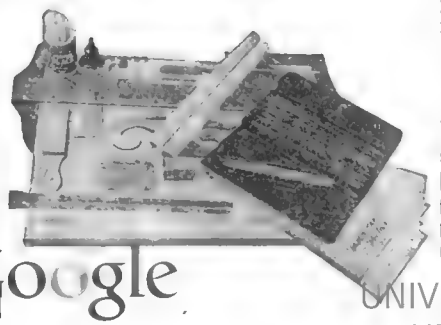

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Can you play a man's part?

Suppose you are walking with your mother, sister, or best girl, and some one passes a slighting remark—won't you be ashamed if you cannot take her part? Well, can you?

Or, if one of your pals says, "Come on, put on the gloves and have some fun,"—can you do it and get any "fun" out of it?

Wouldn't you like to learn boxing and self-defense easily and quickly? Marshall Stillman has developed a unique "Shortcut" Method. You learn the fundamentals in six lessons and can outbox older and stronger opponents after two weeks' study. His original principle enabled him to teach professionals blows and guards they could not learn by the old method.

This is the first time boxing has been successfully taught by mail, and it is only possible because Marshall Stillman starts with movements you are familiar with—reaching out your hand for a coin, the breast stroke in swimming, etc. The first thing you know, he has led you into striking correct blows, guarding, ducking, feinting, etc. He teaches you the rudiments before your own mirror. When you finally meet an opponent, you know where to hit him, what to expect in return, and how to guard against it.

You're taught every good blow and guard used in the ring—the Benny Leonard Triple, the Fitzsimmons Shift, the Mike Donovan Leverage Guard, etc., and three rounds of shadow boxing. You're also taught 12 wrestling holds and 15 jiu-jitsu holds—how to disarm an opponent, how to break a strangle hold, etc. You're given a complete set of muscle-building exercises, the Colon Exercise (good for constipation) and Synthetic Breathing (a lung developer). As an added feature, there's a history of 69 great prize-fighters, with their pictures.

Send no Money

Frankly, you don't believe that you can learn all these things by mail, do you? All right, we will take you on your own ground; we will send you the course on 10-day approval, with the understanding that if you keep it you pay $5 in complete payment on the 15th of the following month, otherwise you return the course in 10 days, and that ends the matter. Simply fill in the coupon—we will do the rest.

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Broaden your shoulders, deepen your chest, enlarge your arms, and get a development that will attract attention. Fill yourself full of energy and be powerful.

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We may be sure that the optic center is not more proficient in the bee than the somewhat similar attachment the optic chiasm is in man, for we find the bee provided with simple eyes, placed practically in the same place as on the human head, and used for seeing things as our eyes see them. Yet until recent experiments proved the usefulness of these eyes, they were supposed to represent useless rudimentary ocular attachments, the common notion being that composite eyes furnish a central picture of all surrounding objects, landscapes, etc.

The number of eyes forming the combination vary in each of the different species of insects and crustaceans, probably because in each the shapes and sizes of the organs vary, and therefore a greater or lesser number of eyes to overcome spherical observation as it occurs in each combination are needed. Properly placed, as we have seen, the eyes are effective in distinguishing single objects as each object is brought within its range, the distance of vision depending on the size and therefore reducing power of each eye. This distance being limited, most objects reflected are seen above, removed from all those outside the range of vision, and stand out as one single definite thing, which can thus be catalogued as an insect friend or foe. If one wishes to prove the use of compound eye, try to catch a fly with the hand. Approach out of range of the simple eyes you will get within seeing distance, or within a few inches, of the compound group before it will fly away—you are a foe; on the other hand friendly insects fly over it, or alight and move close to it, without the slightest concern—the compound eyes have catalogued them as friends.

Home Electrics

By G. L. Hoadley, M.E.

(*Continued from page* 329)

will sometimes make accidental contact with the ground. Such contact may be due to direct connection between the wiring and the earth, or to contact of one wire with a water pipe or gas pipe or the enclosing metal conduit—all of which connect with the earth. One ground on a wiring system produces no ill effect ordinarily. Another ground on the other wire may endanger life or cause a fire.

Suppose a person stands in a bath-room and reaches up to turn on the electric light with the other hand on the water faucet. Or, suppose the person stands in a partly filled bath tub and reaches up to turn on the electric light. Nothing happens *providing the insulation is intact.* If, however, the insulation is worn off so that one of the bare wires touches the brass socket shell, current flows directly thru the person and bath-tub to ground, by way of the water pipe, thence back thru the earth to the grounded generator. While defective sockets are quite common, a person will get no shock if he stands on the wooden floor and turns on the light, for the wood insulates him from the earth. To remedy bad conditions of this sort either use a porcelain socket or else locate the socket so one cannot turn the light on from the bath-tub or while touching a faucet or water pipe or gas pipe or radiator. In order to get a shock by touching a *live* wire the person must form the connecting link for the completion of the circuit. Now, if the person desires to take hold of a *live* wire or to step on the *live* third rail of an Electric Railway System operating at 600 volts, he can do so with some degree of safety if he steps upon the third rail from an insulator, such as wood or the *dry* board walk. Stepping from the running rail onto the third rail or even from the *wet* board walk would complete the circuit thru the person to ground and injure if not kill him. One can, in emergency, walk along the right-of-way of an electrically operated third rail railway safely by simply *not touching any rail. Step over and do not touch the rail!*

Suppose, in some railway tie-up, passengers do find it necessary to walk on the railway right-of-way. Suppose some individual near you, thru ignorance, steps upon the *live* third rail. Prompt action on your part in disengaging him from the *live* rail may save his life. Free the victim from the current by a single quick motion. Use any dry non-conductor (clothing, rope, board). Never use metal or any wet material. Never touch the victim's arms or limbs. Grab his coat-tails, or any loose portion of clothing and break the contact with a quick jerk. If a dry stick is handy, use it to push the wire away or to remove the victim. Then start artificial breathing.

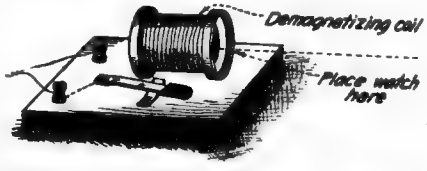

Fig. 5. Another Construction of Demagnetizing Apparatus for Watches.

Suppose in a storm or in cold weather, the 600 volt trolley wire breaks and in falling to the street entangles a person, as shown in Fig. 7. If a dry stick is handy push or pull the victim or the wire away breaking the contact as quickly as possible. If one has on a good pair of rubbers he can take hold of the victim without danger other than that the live wire may entangle him. As soon as the victim is released, get him started to breathing. Do not give up hope but continue efforts to start his breathing for an hour and you may save a life by so doing. But do not put too much trust in rubbers as they are now made.

Send for a physician in all cases at once.

Telephone Amplifier Hurls Sound Four Miles

(*Continued from page* 320)

condenser. In this way there is produced a minute alternating current whose variations are an exact copy of the voice-waves. This type of transmitter is known as the condenser-transmitter.

The minute currents coming from the transmitter are carried over the telephone circuit. In order that they may not be entirely dissipated in traversing the 1000 mile circuit, this circuit is supplied with vacuum tube amplifiers at several equally spaced points giving a relay effect. Much research has gone into the designing of these amplifiers, in order that they may faithfully the currents passing through them without distortion. The current coming from the Catskill end of the circuit was large enough to operate an ordinary telephone receiver, and this, if held to the ear, would give a true reproduction of the speech or music sent from Chicago.

A current of this intensity, however, would be useless if applied directly to the large receivers attached to the loud speaking projectors. Before being sent to these receivers, it undergoes enormous amplification in a vacuum tube amplifier similar to, but much larger than the type used on the long distance circuits of the Bell System. In order that the sounds produced by the projectors should be heard across the valley three miles wide, this special amplifier had to magnify the energy in the telephone cir-

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cuit over 10,000,000,000 times. It is impossible to conceive of just what this means, but of course the most remarkable fact is that this ten billion fold amplification is produced without appreciable distortion.

The amplified current is led to the large receivers, one attached to the small end of each projector. These receivers differ greatly in appearance from the familiar telephone receiver, and are capable of handling currents thousands of times larger. As in the case of the transmitters and amplifiers, an important series of special researches preceded the design of the receivers in order to make them so perfect in their operation as to reproduce sounds without distortion.

For a similar reason, special study was given to the design of the projectors. As will be noticed from the accompanying illustration, these are of special construction and are so shaped as to give a very uniform distribution of sound.

One Orchestra for Five Dancing Floors

(*Continued from page* 310)

and saxophone and one horn in each group playing the trombone and violin; one total group of three horns supplying the floor inside and the other group of three horns covering the outside veranda.

Shunted across the piano transmitter was another transmitter, normally open-circuited, so that by pressing a button speech could be past into the piano-horn of the two groups. In this way announcements could be made, either when the music was playing, or not, as desired.

All the fields of these electrodynamic receivers or telemegafones are in parallel and supplied from a six volt battery, along with all the transmitters in the installation.

In operation the outfit proves very simple. The entire control of the apparatus rests with the drummer. He has the on-off switch at hand, and when they start to play, he simply switches on the battery and the amplified music bursts forth. He turns it off as the piece is concluded, thus saving battery current.

The attachment of the transmitters to the different musical instruments is also simple. In most cases a small screw clamp is used so that the transmitter can be quickly removed when the players leave for the night. Those on the saxophone and trombone are located immediately in front of the bell of the instrument where they will get its full blast and yet be far enough away so as not to choke the sound of the instrument, or prevent it from giving its full volume. The violin has the transmitter held firmly in contact with its vibrating back, where the bridge rests, being contact- rather than air-actuated. The banjo has the opening of the transmitter about one sixteenth of an inch below the drum of the instrument, secured in place by a clamp. The piano transmitter, as above stated, was secured permanently to the sounding board.

The location of the inside horns is such that they clear up the weak spots in the music and make the orchestra very clear and distinct all over the four inside floors. One, the main floor, is quite large, the other three floors opening off from the main floor as large balconies, so the music can be heard and the orchestra seen at all times.

Drive Out
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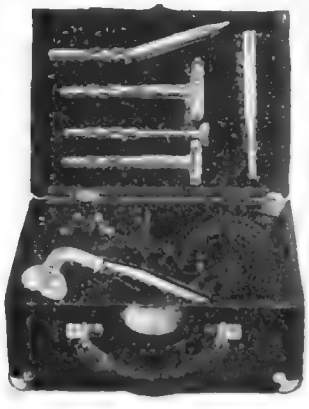

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The installation has by this time paid for itself many times. Before the loud-speakers were installed, very little dancing could take place on the outside platform because of the weak music. As admission is charged, and now that the entire veranda may be utilized, the extra income from gate receipts due merely to the extra number of couples who may dance outside, has proved fully the efficiency of the installation.

So far nothing has been said about the amplification of sound obtained. We have merely described the electrical circuit used in transmitting the music in the most effective manner. But at the same time a great amplification is secured, and on still nights the surrounding ranchers have been able to hear the music from the outside horns, *more than two miles!* At the same time it is not too loud for the dancers. It is a peculiar thing about the loud-speaker here used, that while the sound carries for unbelievable distances, it is never excessively loud close to the reproducer.

Many interesting musical stunts can be accomplished with this installation. Any one instrument can be made to predominate and interesting and unique effects can be obtained. The complete installation was designed and installed by the engineers of the Magnavox Company of Oakland, California.

Data supplied by courtesy of the Magnavox Company.

Radio on Your Vacation

By J. L. ARTHUR

(*Continued from page* 347)

result is obtained. This is very important. The bridle should be secured to the lower end of the vertical stick and to the point of intersection of the two sticks. It should be just long enough to extend from these two points to the tip of the horizontal stick. The string, for normal flying, should be attached to the bridle at the point adjacent to the tip, tho when it is desired to fly the kite on a greater angle the position may be raised on the bridle. Several kites, properly constructed, may be taken apart and packed for carrying in very little space, very little more, in fact, than that taken up by the sticks themselves.

In making the kite covering it is a very good policy to use small brass rings, at the four corners, connected together by light picture wire and accurately spaced. Similarly, two such rings and another length of picture wire may be placed across the back of the horizontal stick to furnish the bowing and may readily be removed when the kite is being carried. It is not advisable to use paper for the covering; it is too subject to injury by water and tearing. A good, light, strong cover may be made from *percaline* and if you are not very handy with the sewing machine, let some of the female contingent of the family do the job of making the covers for you. Of course these kites may be bought, but they are rather expensive and they are really quite simple to make.

Box kites may be used but they require a rather stiff breeze and do not fly as steadily or at such a great angle as those here described.

Kites do not always behave as we would have them do and even the best of them sometimes take to diving for unknown causes. For this reason it is very advisable to fly them, when a wire is used for a string, in a place free from high tension wires over which the kite "string" might cut capers. In using a kite with a canoe, be sure there are a couple of paddles aboard and also be careful to refrain from doing much walking about while in the boat, because canoes tip over rather easily, and even tho you may like swimming, there is no absolute necessity for losing or ruining some of your equipment.

Another Temporary Antenna

We frequently find, especially when it is desired to erect an antenna in some secluded section of the country, that trees will serve very well for the masts which ordinarily support the overhead wires, but climbing trees is sometimes uncomfortable and it is always accompanied by a certain amount of danger. With no climbing and with a great deal more ease, it is quite possible to erect an antenna, for use with the set here described, or any other for that matter, by following the simple methods resorted to by the cave men, when they built their bridges. Supposing that a tree is found which is of satisfactory height, it is but necessary to fasten any kind of a weight—an old porcelain insulator serves very well—to the end of a long piece of stout string. By holding the string about two feet from the insulator and swinging it in the manner of a sling, it is an easy matter to cast the insulator in a manner which will carry the string over the crest of the tree. By cutting the string and placing another insulator on it, to which the antenna wire is fastened and then taking in the slack from the opposite side of the tree until the correct position has been secured, it is possible to have the wire held in any position with relation to the tree we desire. It is well to remember to use the insulators, or there will be a loss of energy.

The Portable Set Itself

From the illustrations it will be seen that this particular portable set includes everything necessary for a complete transmitting and receiving station. The matter of expense is taken care of by reason of the fact that it has been designed to use a complete receiving set, of standard design, with no changes whatever and when the vacation time is over, it is but necessary to withdraw it from the portable case and mount it, cabinet and all in our permanent station. This is a feature which is well worth consideration.

There is room within the case for the carrying of the four dry cells which supply juice for both the transmitter and receiver, the half-inch spark coil, spark-gap, key, send-receive switch, two receiving tubes, two "B" batteries, a pair of telephone receivers and headband, pliers, screw driver, antenna insulators, pad, pencil, etc. The cover of the carrying case makes a very comfortable writing desk and the entire outfit, including antenna wire and ground lead, weighs little more than twenty-three pounds.

Various wave lengths, for different lengths of antenna wire, are indicated on the panel which keeps the dry cells in place. In order to operate the set, it is but necessary to connect the *antenna* to one terminal and the *ground* to the other one of a pair, which are mounted on the outside of the carrying case and are marked "ANT" and "GND."

Regardless of the saving effected by employing a standard receiving set which may be used for the permanent station, as it has a wave length range of 150 to 3,000 meters, it is doubtful if there was a set in any of the signal branches of the Allied Armies, during the war, which was as efficient as the set described, when weight, range, compactness, completeness, ease of operation and rapid setting-up are taken into consideration. A set similar to this would have been of great benefit to any of the signal units. The many advantages to be gained from its use will be instantly recognized by Boy Scouts, as well as by the older radio enthusiasts, who have desired this sort of portable station.

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Practical Chemical Experiments

By Prof. FLOYD L. DARROW

(*Continued from Page* 333)

per cent solution of arsenic-free cupric chloride. Immediately follow this with 5 cc. of the filtrate which may contain arsenic.

Allow the action to continue for a half hour in a good draft or under a hood. (*Remember that arsenic compounds are poisonous and be very careful not to breathe any escaping gas.*) If arsenic is present the filter paper will become stained a yellow to deep orange. If no color appears arsenic is absent.

The copper chloride is added so as to make the acid act vigorously upon the zinc.

In the above manner, test various articles, such as samples of cloth, dyes, highly colored wall paper, commercial zinc, iron pyrites, etc. The two latter may be placed directly in the generator without previous preparation. So, too, usually with a liquid sample.

In removing the contents of the generator *exercise the utmost caution so as not to breathe the contents.*

Flavoring Extracts

Flavoring extracts are among the most common food products to be adulterated.

Lemon Extract: This extract is a preparation made from lemon oil or from lemon peel, sometimes both, and to meet the requirements of the legal standard must contain not less than 5 per cent by volume of lemon oil.

Test for Purity: In a large test tube place 50 cc. of cold water and add 2 cc. of the lemon extract. The lemon oil is insoluble in cold water, and if present will be thrown out of solution, rising to the top of the test tube, and giving a decidedly milky appearance to that portion of the water column. If no such milkiness occurs, it may be taken as a very strong indication, that no lemon oil is present. An approximate idea of the amount present may be gained from the depth of the cloudiness.

Determination of the Per Cent of Lemon Oil: This test is known as Mitchell's Test and is very similar to the Babcock Milk Test described in last month's issue, and the same apparatus is employed.

In a Babcock milk bottle place 20 cc. of the extract and add 1 cc. of dilute hydrochloric acid, made by mixing equal volumes of the concentrated acid and water. Then add 28 cc. of water at a temperature of 60 degrees Centigrade. Mix these well by rotating the bottle, and then stand it for five minutes in a beaker containing water at the same temperature. In order to balance the centrifuge it will be necessary to prepare two bottles at the same time and one test will afford a check on the other. Now centrifuge the bottles for five minutes and add warm water from a wash bottle to bring the separated oil into the graduated neck of the bottle. Centrifuge again for two minutes and stand the bottle up to the top of the oil column for a few minutes, in water at 60 degrees Centigrade. Then take the readings of the scale at the top and bottom of the oil column, just as you did in the Babcock Milk Test, and by difference obtain the per cent of oil. This will be by volume.

There will always be a little oil left in the solution and to correct for this, if the observed per cent is more than 2 per cent, add 0.4 per cent and if less than this amount add 0.3 per cent.

Wood Alcohol: It may happen that an unscrupulous manufacturer has used methyl or wood alcohol, in place of the more expensive grain alcohol as a solvent for the lemon oil.

The method of testing for wood alcohol consists in oxidizing the alcohol to for-

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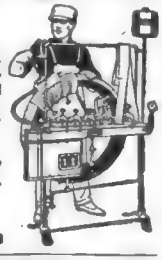

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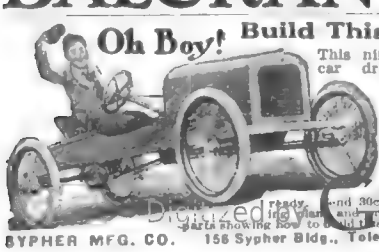

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maldehyde by means of a hot copper spiral and then making the usual formaldehyde test. To make the spiral, cut piece of No. 14 copper wire about 30 inches long and beginning at a point about 8 inches from one end wind the wire closely about a lead pencil to within 8 inches of the opposite end. Then thrust the first end through the coil, and twist the two ends together to serve as a handle.

Now place 10 cc. of the lemon extract in a test tube, and set the test tube in a bottle of cold water. Heat the copper spiral in the oxidizing flame of the Bunsen burner until it has become a dull red. Then plunge the hot, oxidized spiral into the extract. When cold remove the spiral and repeat the process about six times. The hot copper oxide will oxidize the methyl alcohol, if present, to formaldehyde which will remain in solution.

Mix a cubic centimeter of the above solution, which may contain formaldehyde, with half a tumblerful of milk. Pour into a test tube 2 or 3 cc. of concentrated sulfuric acid, and mix with it a few drops of a solution of ferric chloride. Then inclining the test tube very carefully pour down the side some of the prepared milk. If formaldehyde is present, a violet ring will appear at the juncture of the two layers.

In this same manner any other extract or beverage may be tested for methyl alcohol.

Vanilla Extract: Very frequently the extracts sold under this name contain little or no vanila, but consist of an alcoholic solution of vanillin, a substance prepared from coal tar.

To determine whether or not a given sample is a true vanilla extract, prepare a solution of 20 grams of lead acetate, or sugar of lead, in 100 cc. of water. Then to 40 cc. of the sample of extract add an equal volume of the lead acetate solution. If no precipitate occurs, you may be sure that the extract is artificial. If the extract is pure vanilla, a heavy precipitate will form, and quickly settle to the bottom leaving a clear liquid above.

Headache Powders

Such powders very frequently contain a coal tar derivative known as acetanilid. While this compound in the hands of a reliable physician has important uses, as in the allaying of fever, its indiscriminate use is very dangerous. It has a very depressing effect upon the action of the heart. There are a number of tests for detecting its presence several of which follow:

Isonitril Test: Place about a gram of the powder in a test tube and cover it with 10 cc. of a solution of sodium hydroxide, made by dissolving 10 grams of the solid hydrate in 100 cc. of water. Heat the mixture and, upon removal from the flame, very carefully add a few drops of chloroform. Allow the mixture to stand for a few minutes, and if acetanilid is present, the very disagreeable, greasy odor of a compound called phenylcarbamine will appear.

Strobel's Test: Place about a fifth of a gram of the powder in a short, narrow test tube and add an equal volume of zinc chloride. Heat the mixture gently, at the same time holding a wooden splint in the mouth of the test tube. White fumes will appear and the mixture will melt, turn light yellow and finally become black. Observe the color of the splint. If acetanilid is present, it will be stained a yellow.

Paint

A good white paint consists of white lead, zinc white, and linseed oil. Adulterants, however, are frequently added.

Extraction of the Oil: In a small flask place about 5 grams of the paint and add a small quantity of benzine. At the same time have ready a beaker of boiling water. Turn off the flame under the beaker and put the flask with the paint and benzine into the hot water. Agitate the contents of the flask and in a few moments pour off the benzine extract. Repeat this operation, until no residue is left when evaporated on a watch glass.

Now evaporate the benzine extract. Place 2 cc. of the oil that is left upon evaporation in a test tube, warm it and add an equal volume of glacial acetic acid. Cool the test tube and contents by holding in a stream of running water. Then add a drop of concentrated sulfuric acid. If pure linseed oil, it will turn a sea-green.

Testing the Body of the Paint: To a small portion of the residue left after extracting the paint with benzine add an equal bulk of dry sodium carbonate and mix thoroughly. Place this mixture in a small cavity on a stick of charcoal, moisten with a drop of water and heat with the blowpipe. If the paint contains white lead, a metallic globule of lead will be obtained.

Clean out the charcoal cavity, place some of the paint residue in it, moisten with cobalt nitrate solution and heat with the blowpipe. A green color indicates zinc white.

Boil some of the paint residue with strong acetic acid. A residue will indicate some adulterant as barium sulfate.

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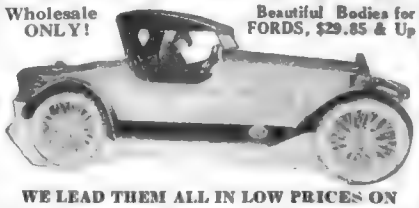

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Popular Astronomy

By ISABEL M. LEWIS, M. A.

(*Continued from Page 331*)

we must place only four and a half inches from the ball of Saturn. We could not squeeze our own six-inch earth-globe between the ball of Saturn and its ring system. The width of the inner ring will be a little over eight inches; this will also be the width of the outer ring; the main central ring will be over thirteen inches wide, and will be separated from the outer ring by a narrow gap of one and a half inches, to represent the division between these two rings, known as Cassini's Division.

The entire width of the ring system in our model will be thirty-two inches, but its thickness will be less than one-tenth of an inch. We may picture the rings as made up of a cloud of fine dust particles in our model, for it is known that the separate moonlets are actually less than three miles in diameter. Were the rings solid it would be possible to roll our six-inch earth-ball along any one of the three rings with ample room on either side.

The entire extent of our model of Saturn including its system of rings is ten feet and nine inches. Compare this with our six-inch globe of the earth or with our model of Mars a little larger than a baseball!

Uranus, the next planet beyond Saturn, will be represented by a globe almost exactly two feet in diameter and Neptune will be a globe with a diameter only two and a half inches greater.

The sun on the scale we have adopted will be fifty-four feet in diameter. It would stand about as high as a four-story building, and we could place, side by side along its diameter, one hundred and eight of our six-inch models of the earth.

The satellites or moons of the various planets differ very greatly in size. Our own moon has a diameter one-fourth that of the earth, and we might represent it on the scale we have chosen by a golf ball, or a large glass marble, one and one-half inches in diameter.

The two small satellites of Mars, which are between ten and twenty miles in diameter, will be no more than grains of sand.

Jupiter's four historic moons are bodies of considerable size, though they appear small compared with Jupiter's great bulk. Satellites III and IV. are both larger than Mercury. We may consider one of them as just equal to, and the other as slightly larger than, a tennis ball. Satellite II will be a large glass marble the size of our own moon, and Satellite I will be just a little larger, a rubber ball somewhat larger than a golf ball, we might say. The other five satellites of Jupiter will compare in size with the smaller asteroids, and we will represent them by small shot or merely grains of sand.

The moons of Saturn also differ considerably in size. Titan the largest is exactly equal to Mercury in size, so it will be a little smaller than a tennis ball. Another moon is about the size of our own moon and the diameters of six others range from five hundred to fifteen hundred miles; on the scale we have chosen they would be represented by marbles of various sizes, ranging from three-eighths of an inch to one and one-eighth inches in diameter.

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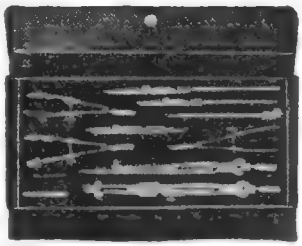

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The four satellites of Uranus have diameters, that range from five hundred to one thousand miles, so we will represent them by marbles, between three-eighths and three-fourths of an inch in diameter.

The one satellite of Neptune is about the size of our own satellite, so we will represent it by a golf ball or a large glass marble.

Let us now undertake to set up our models of the various members of the sun's family at the correct relative distances from the sun using the same scale of six inches to every eight thousand miles.

Starting with what we might reasonably consider a very moderate-sized model of the earth, a school globe six inches in diameter, we have found that on the same scale the larger planets are too large to handle easily while the sun towers in front of us as high as a house.

One person might easily carry the models of our four terrestrial planets. He could slip Mercury into one pocket and crowd Mars into the other and in each hand carry one of the twin six-inch models of Venus and the earth.

One could also carry easily in a small box, say, the grains of sand, various-sized shot and marbles, and several golf and tennis balls, which represent the several hundred asteroids and the twenty-six satellites belonging to the various planets.

The large planets, Jupiter and Saturn, however, we would hardly undertake to carry. We might roll our model of Jupiter along in front of us like a huge push-ball, but we could not do this with Saturn, on account of its unwieldly ring system, which encircles it in the plane of its equator, and gives it an extension of nearly eleven feet in this direction.

The models of the two outermost satellites, Uranus and Neptune, are nearly twins in size, as are the models of Venus and Earth, and as they are about two feet in diameter, one person might carry them both.

Now that we have assembled our models of the various planets, moons, and asteroids, we must choose a suitable place to set them up at their proper relative distances.

We may well imagine that no ordinary-sized field will be large enough to contain our miniature solar system. Let us seek rather a stretch of level prairieland, upon which to set up our system, and after erecting our fifty-four foot model of the sun, we must find at what distances we shall place the various members of his family. Though the orbits of the various planets are nearly circular, they are not exactly so, the true form of the orbits being elliptical, and the sun being not at the center but at one of the "focuses" of each ellipse. As a result the distance of a planet from the sun varies for different positions of the planet in its orbit. As the orbits are nearly circular, however, we will consider that they are so for our purpose, and set the planets at their average or mean distances from the sun. We will also place them all in the same plane though they are in fact in planes that are inclined at small angles to one another.

On the scale we have chosen we find that our six-inch globe, which represents the earth, must be placed one and

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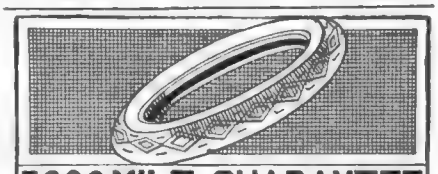

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one-tenth miles from the sun and the small golf ball representing the moon must be placed at a distance of fifteen feet from the earth-globe. The orbits of Mercury and Venus, as we know, lie between the earth's orbit and the sun. Mercury must be placed about two-fifths of a mile from the sun and Venus nearly twice as far away or four-fifths of a mile from the sun.

Next beyond the earth comes Mars. Our model of this planet,—a ball three and two-tenths inches in diameter,—we place one and seven-tenths miles from the center of the system, and its two tiny satellites, represented by two grains of sand, three inches and nine inches from its surface.

The planetoids, or asteroids, come at various intervals between the orbits of Mars and Jupiter. A few of these small bodies come close to, in a few rare instances within, the orbit of Mars and some of the most distant ones come close to Jupiter's orbit. In all there are close to a thousand of these little objects, which we are representing by grains of sand, small shot or beads, and two or three small marbles. We could easily hold them all in one hand.

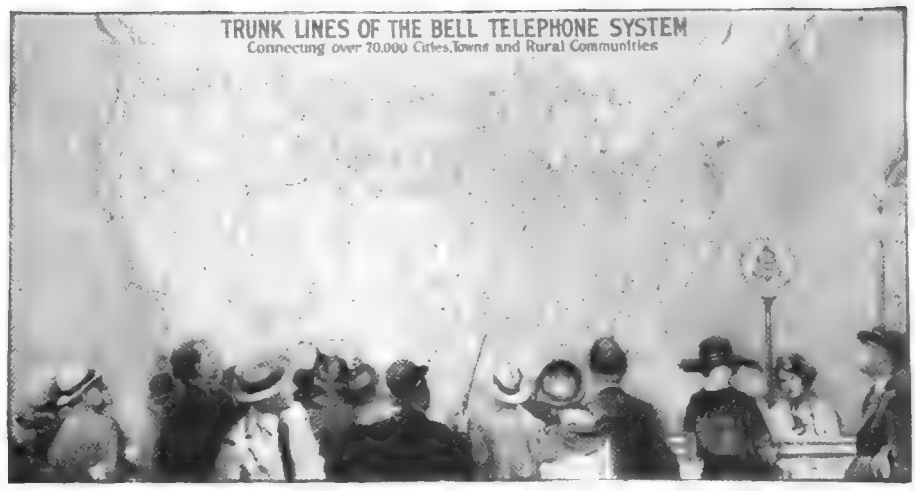
Next beyond the asteroids comes our model of the largest planet in the system, Jupiter. It must be placed at a distance of more than five and a half miles from the center of the system. Jupiter's nearest satellite will be only four feet from its surface but its most distant satellite will be nearly one thousand feet from the planet. Our moon, you will remember, was placed only fifteen feet from the earth. Having placed the nine moons of Jupiter, ranging in size from tennis balls to grains of sand, at the correct relative distances from the huge planet, we proceed to the orbit of Saturn, which lies at a distance of ten and a half miles from our model of the sun. Saturn's nearest satellite, a small marble on our scale, we place only two feet beyond the outer edge of its rings, and its most distant satellite about five hundred feet away. Saturn's satellite system, we find, is only about one-half as great in extent as the system of Jupiter.

After arranging our nine satellites of Saturn, we proceed to the orbit of Uranus. We find that the distances between the successive orbits of the major planets are approximately doubled, as we advance. Jupiter's orbit lies a little more than half-way between the sun and Saturn's orbit. Uranus, we find, lies twice as far away from the sun as Saturn. We place the ball, two feet in diameter, that represents this planet, twenty-one and one-tenth miles from the sun-model. Its four satellites lie between six and a half and twenty-one feet from its surface.

Our model of Neptune we place about twelve miles beyond Uranus and thirty-three miles from the center of the system. Its satellite will be about fifteen feet away from it. In size and distance from the body it encircles, it duplicates our own moon.

As Neptune is, so far as we know, the most distant planet, the diameter of our miniature solar system, in which the earth is represented by a six-inch globe, turns out to be sixty-six miles!

To imitate the motions of the planets in their orbits, let us choose a reduced scale of time for our system, just as we have chosen a reduced scale of distance. Let us assume that in our miniature system a second represents a day. It takes the earth three hundred and sixty-five and a quarter days to complete one



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revolution around the sun. That is the length of our year. In our miniature system, then, we will assume that it takes our six-inch earth-globe three hundred and sixty-five and a quarter seconds to make one revolution around the fifty-four foot model of the sun (6 min. 5.25 sec.). This is the length of the year in the miniature system. It will take the six-inch globe about six-minutes and five seconds, then, to pass over the circumference of its orbit, a distance of about seven miles. While doing this it will turn once on its axis every second which is the length of the day in the miniature system.

On the time scale we have adopted we find that Mercury will make one trip around its orbit in 1 min. 28 sec. Venus will require 3 min. 45 sec. to traverse its orbit. Mars 11 min. 27 sec. Jupiter 1 hour and 12 min. Saturn 2 hours and 59 min. Uranus 8 hours and 31 min. and Neptune 16 hours and 43 min.

Mars and the earth will each require one second to turn on their axes and the moon will turn on its axis, and make one revolution around the earth, in a little over twenty-seven seconds.

Jupiter and Saturn, and (probably) Uranus and Neptune, will turn on their axes in less than half a second. (The rotation periods of Uranus and Neptune are not known as yet, but are believed to be very short). Mercury will turn once on its axis in 1 min. 28 sec., the period of its revolution in its orbit and so keeps the same side turned toward the sun. It is generally believed now that Venus also turns once on its axis in making one trip around the sun, if so our six-inch model of Venus will turn once on its axis in 3 min. 45 sec. and, like Mercury, will keep the same face turned to the sun. Our miniature sun will turn once on its axis in twenty-five seconds.

The nearest star is at a distance of two hundred and seventy-five thousand times the distance from the earth to the sun. As we found that our six-inch globe, representing the earth, would be one and one-tenth miles from our fifty-four foot model of the sun, the nearest star on the same scale would be more than three hundred thousand miles away from our miniature solar system with its diameter of sixty-six miles. The actual average distance of the moon from the earth is 60,000 miles less than this distance, which has been scaled down from realty to fit into our model!

If we should use an automobile to set up our models of the different members of the solar system and start from the point where we had placed the model of the sun with a speed of sixty-six miles an hour, which is faster than the fastest express trains travel, we would reach Mercury's orbit in twenty-three seconds, the orbit of Venus in forty-three seconds, the earth's orbit in exactly one minute, Mars' orbit in one minute and thirty-one seconds, Jupiter's orbit in five minutes and twelve seconds, Saturn's orbit in nine and a half minutes, the orbit of Uranus in a little over nineteen minutes, and the orbit of Neptune in almost exactly one-half hour. We could cross our miniature system at this rate in one hour. If we wished to cover a distance equal to that separating the system from the nearest star on the same scale, however, we would have to travel day and night without stopping at the rate of sixty-six miles an hour for more than six months! Then we would have covered a distance equal to that separating the model of the system from the model of the *nearest* star only.

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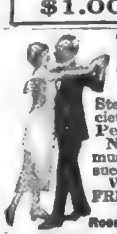

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The Red Vote

By HAROLD F. RICHARDS

(*Continued from page* 317)

upon seeing the bull fight in Buenos Ayres that evening, but I was tremendously interested in Jiordano's story.

Elon continued his efforts to elicit information from Jiordano.

"Who managed the campaign of Desuchez?"

"I did most of the work. My wife helped me greatly. She is a born general, Hopkins. But now, she is broken."

"And the President's personal enemies?"

"Surely, Hopkins, the motive is obvious," responded Jiordano, testily. "What other incentive is necessary than the desire of a minority party to get into power?"

"Nothing is obvious in the detection of crime, Jiordano," curtly replied Elon. "The President is still unmarried?"

"Yes."

"He has had affairs?"

"None. His sole interest has been improvement of the people's conditions."

"Jiordano, it is still possible to get this steamer back to Buenos Ayres in time for the evening's amusements. Will you give me full information or not?"

"My dear Professor, I'll——"

"I remember a news item of three years ago, Jiordano. It mentioned your wedding to Carlina Camboles, and made much of her previous infatuation for the President." Elon eyed the minister keenly.

"The reports were greatly exaggerated, Hopkins. A passing fancy, you might say. It disappeared when she met me."

I caught a sidelong twinkle from Elon's blue eye, as the minister pompously swelled his thin chest.

"And your international relations?"

"Perfect, I assure you."

"The French government was satisfied in the affair of the *Vainquer*?"

"We finally made full reparation for that loss."

Elon settled back in the cushions and seemed to doze, but I knew that he was already formulating plans. Jiordano strode nervously up and down the narrow cabin, occasionally darting out upon the deck, where I heard him urging the captain to greater speed.

I readily recognized Montevideo as we steamed into the harbor. Mount Cerro towered in solitary grandeur above the plain on which the city lay. I was eager to see the town, which I had heard described as the Paris of South America, and was somewhat disappointed to enter it in the middle of night. But a strange scene met us as we rode thru the streets in Jiordano's machine.

Instead of darkness and quiet we found in the city a blaze of light, and great crowds surged up and down the streets. The glass-canopied cafés on the sidewalks were jammed with excited throngs, and here and there we saw men fighting in individual brawls. In one café a beautifully attired woman was standing on a table, earnestly haranguing the dense mob, which broke into fervid applause every few sentences. As we made slow headway along the packed boulevard, Jiordano pointed to the speaker.

"See! Already they are inciting the people to crush the Cambadieras."

At the plaza we detoured around a mass of a thousand people. They seemed to be listening with sullen and reluctant obedience to the speaker.

"My wife," said Jiordano, pointing proudly to the figure on the platform. "But she can not restrain them long."

We drove immediately to the State House, for Elon wanted to see the ballots

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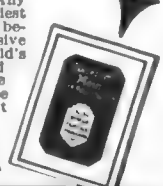

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at once. Jiordano ushered us into his sumptuous office and gave quick orders to his secretary. Soon a hundred of the ballots were placed on the desk before us.

"They certainly are marked for Cambadiera," mused Elon, fingering rapidly thru the pile. "This is a good grade of paper, Jiordano. Who does your printing?"

"Lescal and Cano. They have the concession to furnish all materials for the elections. They put up the voting booths and print the ballots."

Elon placed a blank ballot in a large brass jardiniere and applied a match. When the paper had burned out he exmained the charred residue with his pocket microscope, then rubbed the ashes between his fingers.

"This fiber is peculiarly French, Jiordano."

"That's strange. I understood they bought their paper from a concern in Buenos Ayres."

The door opened suddenly and a woman ran excitedly into the room.

"Oh, Pascale, I can't hold——"

She stopt quickly as she saw that Jiordano was not alone.

"My wife, Professor Hopkins. And Mr. Andrews. Carlina, Professor Hopkins has come to solve the election."

"You will save so much blood, Professor. We are helpless. You *will* do it, won't you?"

She threw out her arms in a captivating gesture of appeal. I could not help but admire the poise and grace of her bearing. She wore a black evening gown, and the filmy white gauze about her shoulders did not conceal their exquisite ivory. Her eyes sparkled brilliantly under a high forehead, and a wealth of coal-black hair crowned all. A sphere of magnetic influence seemed to envelop her, and I found myself questioning vaguely how the Nationalists could have lost with such a woman campaigning for them. The smooth lines of her face spoke of keen and incisive intelligence. She seemed to tower above her husband.

"I will do all I can," promised Elon. "But now we must get some sleep. By the way, where can I find Lescal and Cano?"

"Their establishment is just north of the Plaza. You can't miss it," responded Jiordano at once.

"I guess you won't mind if I take one of these ballots with me. Also one of the blank ones. By the way, do you always have your ballots printed in red?" he asked, with a sharp glance at the minister.

"Always. The people love the color."

"I see. And who managed the campaign for Cambadiera?"

"Glauvère, a Frenchman who has lived here for some years. But they hardly did any electioneering, you know."

"I'll let you know as soon as I find anything," promised Elon, and we left unceremoniously.

As we entered the San Carlos Hotel we found an atmosphere entirely different than that of the cafés. Here there were swarms of people, too, despite the lateness of the hour, there was an air of gaiety and revelry, but on the whole it was an evil-looking crowd, and I judged at once that this was the Cambadiera faction celebrating the unexpected victory. Women careless as to whether their slender shoulder straps remained in place or not were drinking with men whose faces were ingrained with sensuality. Many were dancing between tables, and on corner sofas lolled couples in positions not ordinarily meant for view. One man, an undersized figure with large head and two leering brown eyes, seemed to be leader in the revels. As we registered, Elon asked the clerk who the man was, and he haughtily replied that it was Glauvère, manager for Cambadiera. Apparently we were in the enemy's territory. I noticed many eyes riveted on us as we entered the elevator.

(Continued on Page 368)

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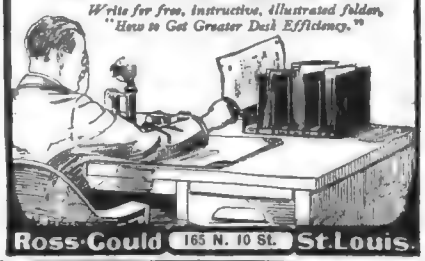

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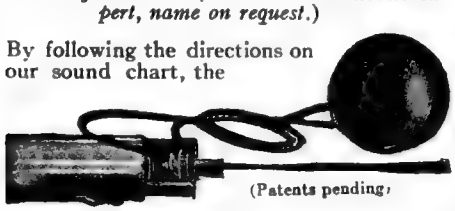

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The Red Vote

(*Continued from page 366*)

We entered our rooms, lay down, and dropt immediately into a sound sleep, for morning was not far away. Suddenly I awoke, and found Elon shaking me violently by the shoulder. I rubbed the mist from my eyes and tried to sit up. My limbs seemed half-numb. As soon as Elon saw that I was aroused, he sprang from the bed and immediately I felt, rather than observed, the cessation of a buzzing sound. Elon dashed to the door, then seemed to change his mind, and flung open a window. The gusts of cooling air relieved me at once, and I sat up quite conscious.

"Someone seems to dislike our entry upon the scene," he observed, holding up for my inspection a little motor that he had disconnected from the electric light socket. "Somebody has slipt into the room and attached this aspirator to the circuit, and the infernal thing has been spraying us with chloroform."

I gasped as I realized what a close call it had been for us.

"The whole Cambadiera crowd saw us come into the hotel," I said. "And I wouldn't be surprised if the clerk were in with them. We'll have to be careful."

Elon stooped quickly to the floor.

"Hello! Here's a souvenir."

He held up a postcard. Together we examined it. The side for address and message was entirely blank, and the reverse bore a simple landscape in red n one corner we noted the trademark of a Parisian printing concern

"Whoever owns this card is the one that tried to remove us so quietly and painlessly," mused Elon "It wasn't on the floor when we retired for I examined the room carefully "

After our few hours of sleep we were ready to continue the investigation. Elon was as impatient as a cocained racehorse.

"I m going down to the printing place, Sprigg You might be nosing about town," he flung back as he strode swiftly away.

We met by appointment at noon and ate luncheon in a little caf near the outskirts. Elon had insisted that there was no telling what might happen to food at the San Carlos after the pleasant episode of the night.

"Find anything?" I queried, as I cut into a beef pie that contained enough seasoning for the whole cow.

"Not much—directly," he replied significantly. "I have samples of all their inks. It's a good thing Jiordano assigned me one of his men, or Cano would have been quite nasty. Lescal has been out of the business for years and Cano runs it. He has the concession to equip voting booths and furnish printing for the entire election. The system of voting seems to be uniform thruout the country. Everything is centralized, and out in the country the people must travel a great distance to vote. Cano tried to hide a cask of liquid that I found there. I can't quite make him out. Jiordano said that he was wholly a creature of the government. What do you know?"

"Cambadiera must be a figurehead, for Glauvère is walking about town like a lord. He made a speech on the Plaza, and it certainly looks as if, after January first, this town will run Shanghai a close race for the honor of being the most licentious city in the world. He had a beautiful woman on the platform with him, and at the close of his talk he embraced her openly. I found out that she is Angelè Hervé, and has been his mistress in a quiet way for several years. He seems to have an enormous gang of free-booters on his staff, now that the election has been won."

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"Hervé, you say? French paper in the ballots, French postcard in our room, French mistress of Cambadiera's chief lieutenant. The gravy becomes gelatinous, Sprigg. Anything more?"

"I met Carlina near the Solis Theatre and she took me to a voting booth in a barber shop. That woman is a brick, Elon. She's worrying her heart out over this revolution she sees coming. The voting booths are just like ours. Everything seems quite regular, and we have Jiordano's word for it that most of the election officials were Nationalists."

"What kind of lights do they have in the booths?"

"Electric, with red bulbs. This country seems strong for red. I read a paper under one lamp and found the illumination plenty strong enough. There can't be any chance that mistakes were made because of insufficient light."

"Sprigg," he chided, with a condescending smile, "I fear you haven't studied the laws of probability. If the errors had been due to faulty illumination the chances are that the same number of ballots would have been marked for each candidate. There would be no possibility of ninety per cent of the errors occurring on one side. However, your information is interesting."

Elon was eager to examine samples of paper that he had obtained, so we returned to the hotel. He worked in silence for some time, turning on first a bulb of one color and then another. Finally he looked up with the expression I knew so well, and I felt that we would not labor much longer on this particular case. I wondered how Glauvère had done it, and whether the printer Cano was implicated. Then I found myself thinking warmly of Angèle, and I hoped that she would not be involved with Glauvère. Somehow I hated to think of her paying the penalty, for Jiordano had said that the law considered tampering with an election to be treason. But I felt glad that Carlina's worries would soon be banished.

Elon startled me out of my speculations by announcing crisply:

"I'm going down to the public hospital. While I'm gone you might engage the two rooms adjoining this, one on each side. If they are occupied get some other suite of three adjoining rooms. Pay that suspicious clerk any bonus he asks. And get two dominoes. We must attend the masque ball tonight."

Before I could voice my surprise he was gone. I made the arrangements as he had ordered, and after he returned we had quite a task fitting up the suite as he wanted it. At eight-thirty we heard the orchestra strike up in the ballroom, and an hour later we went down in our evening clothes. Our only disguise consisted of the dominoes over our eyes. Elon had decided that it was no use trying to conceal our identity.

Around the decorated ballroom circled couples, costumed as slim fools, fat priests, white-capped nurses and dancers from the Orient, dignified generals in full uniform and ladies radiant in evening gowns. It seemed that every race and colorful type had sent its ambassador to this conclave of joy and riot. Great domes of glass, suspended from the ceiling, cast a soft cloud of rose-colored light upon the whirling dancers. A monk with saintly mask passed us, holding in his arms a baby-doll. His flowing robes became entangled with the unclad knees of his full-grown infant-in-arms, so he hoisted the flounce of his gown over his shoulder and danced on, the checkered trousers of a sport suit showing incongruously below his holy robes. From his big head, short stature and leering eyes I knew at once that it was Glauvère, and I reflected that he had a sense of humor in choosing monk's costume. His partner was Angèle, and I thought her harem garb quite appropriate. I wondered again whether she

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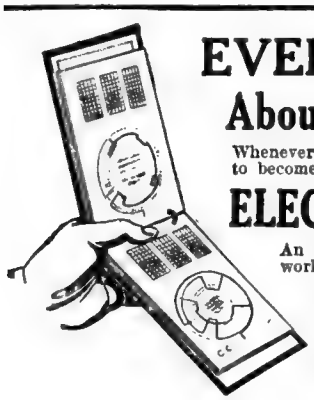

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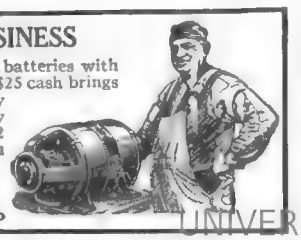

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would be involved in Elon's disclosures, and felt a sense of guilt as I watched the rhythmic motions of her lithe figure, with its rounded calf and half-clothed bosom swelling oddly against her baby's disguise. I turned to Elon and remarked jocularly:

"She certainly is a model of superior design and perfection of movement. It seems a shame to prove anything against her."

He smiled significantly, and directed my attention to a stately figure drest as Martha Washington. I was surprised to see that costume so far from the States.

"That's Carlina, dancing with Jiordano."

"How can you tell?"

"Watch her hand. See how she continually moves the little finger. She has most unusual control over it—I noticed that last evening at the State House. She must be a pianist of no mean ability."

I watched her for a moment and mentally wondered why it was that her dignified garb spoke more eloquently of smooth lines and graceful curves, than did the brazen frocks of adult infants and pink-pantalooned dancers from Siam. But my pleasant meditations were cut short, for Jiordano had observed us and come up to speak.

"I do hope you have learned something, Professor Hopkins," exclaimed Carlina impulsively, extending a dainty hand.

"I think we shall be able to make certain disclosures before the evening is over," he replied, smiling coolly.

At this juncture a tall man in sedate evening clothes approached, and Jiordano introduced him as Desuchez. His angular frame was bent and his unmasked face was lined as with sleepless nights and mental anguish. His features called to mind the pure resolve and high purpose so apparent in portraits of Lincoln, altho he did not have the rugged strength of our martyred president. I raged inwardly at the thought of such a man being displaced by the figurehead, Cambadiera, whose followers reminded me of the habitués of a Montmartre or the Bowery of twenty years ago.

"We hope to prove that the election was a fraud, Your Excellency," remarked Elon, eyeing the President keenly.

"It is not so much for myself, But the country, man, the country!" His sad eyes lit with sudden passion. "Cambadiera will ruin our law, our business, our morals. The people will not suffer it. There will be bloody revolution. Ah, Professor Hopkins, if your science can prevent this, the people of Uruguay will owe you an unrequitable debt."

Elon merely smiled, as if the debt were already contracted. I asked Carlina for the dance and we glided away. A thrill went thru me as I found myself so near to the magnificent creature in whose behalf we were laboring. I had not the shadow of a doubt that Elon was about to clear up the mystery of the election, and congratulated myself upon having a hand in helping Carlina. Under the intoxication of her closeness I felt Jiordano, Desuchez, nay even all the people of Uruguay, shrinking into insignificance, and I rejoiced solely that we were about to effect a solution that would relieve her anguish. I threw caution to the winds.

"Tonight the treachery of the Cambadieras will be disclosed," I whispered into her ear.

"I hope so much that you are right," she answered, and I felt her bosom heave. But her vibrant strength seemed to leave her, and she rested heavily on my arm. I ground my teeth in inward rage at the villainy of Glauvère and his crowd, that had brought such troubles to one so beautiful.

I looked across the hall and started as I recognized Elon's tall and dignified figure whirling about with Angèle, mistress of Glauvère. The tails of his coat flapt far below the flounce of her infant's frock, and I smiled as I thought that he must be get-

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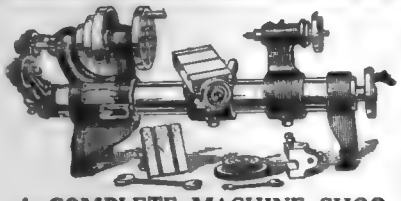

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ting powder on his lapels. They were talking with animation and I saw her smile at some remark of his. For the moment I envied him, for Angele was certainly easy to look upon. I have never been quite able to reconcile myself to Elon's practise of using his clever conversation and engaging manner to elicit some link of evidence from a woman under his suspicion. But he has always smiled at my remonstrances, saying that I am too susceptible to feminine charms.

I heard the big clock in the lobby strike eleven, and wondered when Elon would begin his demonstration. I was standing with Carlina. Suddenly he seemed to appear from nowhere with a little group around him. Jiordano and Glauvère were walking far apart and studiously trying to appear unconscious of each other's presence. Desuchez was there, and Cambadiera. This was my first glimpse of him. He was a striking animal, but I thought he would do better as director of a musical comedy chorus than as president of a republic. Angèle walked with Glauvère. A man whom I did not know was in the party, and Elon whispered to me that he was Cano, the printer.

I wondered how Elon had been able to get them all together and what club he had held over their heads. The dance had stopt and all eyes rested upon our little party as we entered the elevator. Elon arranged them in a semi-circle in the middle room of our suite. I wondered why he placed them so close to the wall. Glauvère sat on the end, Angèle next to him. Then came Cambadiera, Cano, Jiordano, Carlina and Desuchez. Nobody spoke. The very air seemed charged with some tense electric ether. I was reminded of a spiritualistic séance, that I had once attended, they seemed so absorbed in looking for revelations from above.

As always under such conditions, Elon dove into the midst of the matter.

"I have here a postcard, carelessly left by a visitor to my room. The card is a French one and I find that none like it can be bought in Montevideo. It bears no stamp nor address, so obviously it must have been sent in a sealed envelope. This is a little unusual, for it is really a cheap card and needs no protection. You all see the design?"

Apparently the little audience was wondering what connection the harmless red landscape had with the case in hand. Elon said nothing, but turned a switch at the wall. The room was flooded with brilliant red light.

"Now look at it," he commanded.

There were quick intakes of breath. I looked at the card. The red landscape had disappeared. In its place was a bright picture of a shapely woman, nude. Angèle laughed softly, and I wondered how she could so well conceal her trepidation. Carlina turned her eyes away in mute protest. Jiordano sprang angrily to his feet.

"I did not bring my wife here to be insulted, Professor Hopkins. You said you had facts to present."

"So I have. The owner of this card is responsible for the defeat of the rightful president of Uruguay."

Jiordano subsided, and Elon took from the table a piece of paper, one of those upon which I had seem him experimenting. He quickly turned off the red lights, switched on the white, and held the paper in the air.

"You see it is entirely blank. Sprigg, will you kindly turn on the red light?"

I did so, and the party gasped as the name of Cambadiera stood forth in bold red script upon the surface that had been blank a moment before.

"I have merely written on the paper with *quininum ruber*, one of the salts of quinine. The solution is a colorless chemical when viewed in white light, but is brilliant red in red light. This is a common method used in Paris for printing lewd postcards. The cards come with a red mica screen, which

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when placed over the picture renders the innocent red landscape invisible and allows the lewd design to appear."

He didn't wait for comments, but raced on.

"This ballot, you see, is marked for Desuchez. I turn on the white lights, and you see it plainly marked for Cambadiera."

Muffled gasps burst from the row of auditors. I noticed that Glauvère and Angele were sitting stiffly erect, hardly breathing. Cambadiera seemed to be as much surprised as Jiordano. I wondered if he had not known of the fraud in advance.

"The ballots have simply been printed twice, once in red type with the Cambadiera column on the left, and once in *quininum ruber* with the Desuchez column on the left. The voter marked his ballot, in red light, for Desuchez. The ballots were counted in white light, at the State House, and the crosses were found above Cambadiera's column. Your Excellency, I congratulate you upon re-election to your well deserved post."

Quickly Elon turned from Desuchez to face the group.

"If you will kindly wait a moment, I have something further to reveal. Sprigg, will you come with me?"

I was dumbfounded at his leaving the Cambadieras alone, but my surprise was intensified when Elon received a roll of celluloid from a man in the next room, and in the twinkling of an eye was projecting on the white wall a moving picture of skeletons.

"Please be calm," requested Elon. "This is simply an X-ray movie of the audience in this room. Every move made during our little conversation has been recorded on this movie film. In the room behind you has been operating a powerful X-ray apparatus.

"The white numbers that you see on the screen indicate the person to whom the skeletons belong, for each chair, has a lead numeral. Thus we can identify the skeletons.

"Here is the beginning of the picture. You will note that you all sat very still until I produced the postcard. My hand here, upraised for the second time, shows that I was exhibiting the transformation of the card under the red light. There was a general movement, but Number Six gave an intensive tremor that persisted for several seconds. Evidently Number Six was much moved by the card."

The awe-struck witnesses twisted suddenly to feel what number might be stuck on their backs, but Elon held their attention.

"We will pass rapidly over the middle part of the film, which reveals nothing of importance. Here we see Mr. Andrews and myself leaving the room. You all move restlessly, but Number Six rises immediately and goes to the opening of the mail chute. Sprigg, will you kindly run down and see what was dropt into it?"

I started to go, but was arrested by a shriek behind me. Carlina had sprung to her feet and was waving back and forth unsteadily. With great effort she calmed herself and said coldly:

"Don't trouble yourself, Mr. Andrews. You'll only find more of the postcards."

Jiordano sprang to his feet.

"Carlina! You!" he cried.

But she waved him back and poised dramatically before Desuchez.

"No man can scorn Carlina Camboles and enjoy life and honor. You are restored to the presidency, but you won't—"

Elon jumped forward, in time to knock her revolver into the air. The shot struck the wall harmlessly above the head of Desuchez. Jiordano recovered from his amazement and sprang to clutch his wife. He was too late. Her second shot pierced her breast. Glauvère stept to Elon's side, with Cambadiera on his arm.

"Professor Hopkins, while you have taken the election from us, I must thank you for proving that we are not as bad as we seemed. To tell the truth, we were as much surprised at the result of the election as were the Nationalists. Desuchez, accept our congratulations."

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Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

Spark Plug

(465) Edwin S. Warner, Mohnton, Pa., writes, "Can I get a patent on a spark plug with removable points?"

A. Although we believe that the spark plug, a diagram of which you have forwarded, is patentable we doubt its commercial value. There are spark plugs with adjustable points which may be filed, scraped, or otherwise treated in order that they shall present clean surfaces.

The points may then be pushed further apart or pressed together. There are other plugs which present hundreds of sparking surfaces and which are not as inconvenient to handle as the unpointed plugs.

In addition, all spark plugs become carbonized to a very great extent and we believe it will be rather difficult for you to remove the points after they have once been inserted and allowed to operate in an engine for two to three months.

We would not advise patent.

Telephotography

(466) Edwin Warren, Los Angeles, Calif., asks for advice on a telephotographic recorder operating on the principle of an oscillating mirror, which reflects light upon a photo-chemical substance.

A. We are in receipt of your recent communication, regarding a system of telephotography. We do not believe that this device is superior to the Belin system, for several reasons.

In the first place, the oscillating mirror would tend to cause a blur. In the second place, the selenium cell could not possibly pass enough current through the electromagnet to operate it successfully.

An oscillating mirror could never have the effect upon a photographic drum comparable to the intermittent effect produced in the Belin system.

Again! ! Perpetual Motion Machine

(467) Francis Werner, St. Marys, Pa., says: "Why won't this perpetual motion machine work?" He then describes a machine wherein a steel ball rolls up an inclined plane and when it reaches a certain position the magnetic force which pulled it up is cut off by an insulator and the ball rolls down again.

A. The machine described will not work for several reasons; chief among these is the fact that up to the present time no insulator of magnetism has as yet been discovered. A piece of wood will not answer as an insulator, as specified, because it will have no insulating effect.

Telephone "Lock-Out" For Party Lines

(468) Greg. Voyentziz, Petersburg, W. Va., offers a plan to prevent listening in on party telephone wires, whereby lamps will light up if another subscriber removes the receiver.

A. Altho the writer can see many novel and radically new improvements in your system of party line telephony, there are many changes, which could be made so, as to cut down the expense and still obtain the same effect.

For instance, instead of signal-lights and miniature lamps, which are expensive to operate and consume current all the time that the line is used, the bulbs breaking easily,—you can use automatic drops of the self-resetting type on a trigger arrangement which will detect any party along the line raising the receiver or releasing the hook, while another party was using the line. This would stop "listening in" entirely.

Past experiences, which some of our clients have had with the telephone company, would, nevertheless, place your patent in an unfavorable light,—altho an improvement, it also means an expense and also necessitates additional repair men.

Such improvement to the phone service is not looked upon favorably by the telephone company, as it does not give better service, therefore they may not think it essential.

Perpetual Motion Again?

(469) A. G. Vangesen, Picton, Ont., Canada, submits a mechanical scheme, using permanent "copper" and iron magnets coupled to a series of spokes revolving within a wheel similarly arranged.

A. Your device is nothing but a perpetual motion scheme, and the power put into it will be much greater than the power derived from the same.

Your model cannot possibly become a commercial proposition, neither will it work. Such a thing as a copper magnet does not exist.

Talking Movies

(470) Thos. G. Staley, Portland, Oregon, asks several questions on talking-motion pictures.

A. There is a great demand for a machine which will make possible talking motion pictures. The principal requirements for such a contrivance are absolute synchronism of voice and film; a method whereby even if the film parts as it sometimes does, particularly when it breaks, this synchronism will not be lost, and at the same time an exclamation like O Helen! will be cut to O-----H!

Hundreds of patents have been issued on machines of this nature, but not one of them is as successful as desired. For instance, some of them photograph the voice upon the film, others inscribe the voice upon a steel wire as in the Poulsen telegraphone. A third, uses phonograph records in conjunction with the film. Each and every one requires complicated mechanisms to obtain the required synchronism.

Wave Motor

(471) E. David Stenberg, Seattle, Wash., submits a drawing of a wave motor comprising a raft and a large bell shaped chamber connected at its upper extremity with pumps to compress air so that as the raft rises and falls, the air volume increases or decreases and works the pumps.

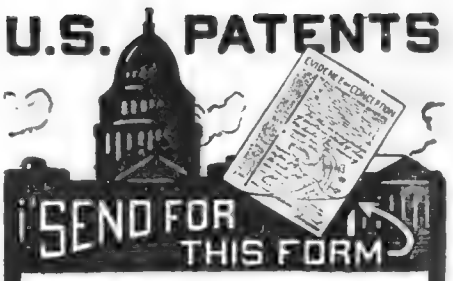
A. We do not see the possibility of applying your device for power development for many reasons. In the first place, the raft containing the chamber will move up and down upon the waves and therefore, very little change in air pressure will be affected inside the chamber. Then you attempt to make this air pressure operate an automatic pump and pump water which it will not do.

We advise you to study the construction of the whistling buoy, used in the U. S. lighthouse buoy service; this is a wave motor supplying a flow or current of air for a signal whistle.

There are many other wave motors which have proven far more successful than you could ever expect this device to be.

We trust this candid opinion will not deter you from further experiments.

U.S. PATENTS



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Lock Nut

(472) Rafael Diaz Sedano, Havana, Cuba, enters a description of a new lock-nut and asks us whether he should obtain a patent on it. The lock nut has one side flattened.

A. You are defeating your own purpose and definitely say so in the description you have rendered of the washer where you state "while the bottom part of the washer is made straight in order to prevent the said washer from turning around, thus locking itself." From this it is obvious that the position of the bolts must be near some projection so that the straight edge can get a grip on another part of the apparatus. In many pieces of apparatus no such stop presents itself, and therefore such a washer would be of no practical value in the broadest sense.

In view of the countless nut-washers on the market today which can be placed on any nut, regardless of where the nut may be, and which *do* lock the nuts, we would hesitate to advise a patent.

Ship Salvaging Scheme

(473) J. C. Setlow, Hopkins, Minn., submits a description of a deep sea salvaging device and asks our opinion on the same.

A. The editor of this column will admit that your machine has many clever characteristics, but he does not hold that the machine is different enough from the Soisson apparatus to give you ground for basic patents.

The Soisson apparatus likewise can be floated without any agency from above, and it can likewise be be fitted with mechanical arms, which in themselves are nothing new. The editor does not hold the same opinion with reference to the fact, that your apparatus is the most flexible, altho he will admit that he has not seen a working model of it to make this last qualification absolute.

Nevertheless, should you desire to enter the very promising field of sub-sea salvage, the writer wishes you every success. The field is large enough to accommodate thousands of apparatuses and more thousands of ideas.

Free Power For Auto — All But?

(474) William Rice, Dallas, Texas, submits a drawing of an automobile to the propeller shaft of which is attached a generator, and a motor, and wants patent advice on it.

A. Your query again brings up the old far-fetched idea of impossible perpetual motion, practically the same as connecting a dynamo to a motor, starting the motor at first from an external source of power.

When the motor has obtained full speed, it will of course, generate electricity by turning the dynamo; then if the dynamo is connected to the motor, it should continue to go on forever, only it will not.

No, Mr. Rice, the thing is impossible and we would not give it a second thought.

Cocoanut Oil Shampoo

(475) Gustave Soeder, Brooklyn, N. Y., submits a sample of a neutral shampoo and wants to know whether he can manufacture it.

A. Cocoanut oil shampoos are often mixtures for which no patent is obtained. Therefore you could go right ahead and manufacture it or place it in the hands of a large concern who will manufacture it for you, and put it up in bottles with your label attached. A copy of the label should then be sent to the Patent Office, so as to register your trade mark, altho it is not absolutely essential that you do this, but it will prevent other individuals from using the same name which you may have advanced and given great publicity to.

There are numbers of concerns in New York and Brooklyn who will manufacture the shampoo for you at a nominal price and put it up in bottles, label and carton it. Your local druggist will tell you the names of two or three of these, and if you cannot secure these from him, write us further about it.

The product does not have to be patented. A secret process is even more valuable at times than a patent, as long as the secret does not "leak out."

Patents

By James A. Sanaker

I spend my leisure makin' things
That never seem to run;
My drawings and my reckonings
Don't pan out right when done.

And still I'm everlastingly
Beginning something new;
While hoping yet to see the day
When Fortune sails in view.

My tinkerings and putterings
May seem a foolish waste;
For I do no inventing,
In any kind of haste.

I'll keep it up, I guess, until
The day I pass away;
I know at least I've plenty
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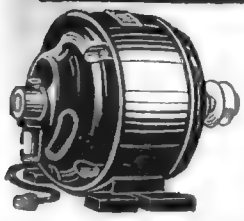

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Small House Refrigerating Machine

(*Continued from page 337*)

By JOHN GORRELL

which is placed in the head. This cup which contains the release valve is welded shut after the lever has been removed. (Care should be taken so as to allow sufficient room for valve stem. If the cup is filled with metal it will hold the exhaust valve open). The cup is screwed down and a good gasket made of drawing paper, well shellacked, put in.

The gas may leak out on the drive wheel side of the compressor past the shaft and out of the drain, which carries the excess oil to the crank case. Both of these are stopped by cutting off about one quarter of an inch of the shaft and milling the drain port to the same plane as the rest of the casting.

A sheet steel cap is made which is placed on the opening and when screwed tightly on the gasket will successfully prevent the gas from escaping at these openings.

No. 4. The vent under the flywheel side of the crank case must be milled to a plane, and covered by screwing a sheet iron plate over it.

No. 5. The gas will leak past the bearing on the driven end of the crank shaft. This is overcome by removing the old bearing and boring the opening larger. A new bushing, of the best obtainable bronze, is then made, about an inch larger than the old one. An inside thread is cut in the projecting end and another piece of bronze is turned up and drilled, in order to make an inside stuffing box. This box should contain ordinary white cotton string saturated with oil and powdered graphite.

It is desirable to put a spring in the stuffing box so as to make it self tightening.

No. 6. A method of closing the opening in the crankcase, which contains the oil gage, is to be worked out more or less by the builder.

The object is to close the opening so the gas cannot escape, but not so as to hinder the passage of oil and the reading of the oil gage (which must be placed in the system) and to make an air cushion.

By looking at figure 3, the reader may see a projection of the part of the compressor concerned.

A small piece of pipe is run out of the opening down and out to the tee. The gage glass and by-pass are placed as shown. (Great care should be taken to see that all joints are air-tight.)

The air cushion should be made of 14 inches of 2½" pipe or anything with equal or greater volume. This pipe is capt at both ends. A pet-cock is placed in the top for oiling.

When the machine has been tested for leaks and found intact, the pet-cock should be opened and filled with oil (while the machine is at rest). Close the pet-cock and the machine is ready for use. (*Never* under any circumstances permit the oil level to go below two and one half inches from the floor base of compressor). Always take reading when the machine is not running.

The idle pulley is not used and will have to be removed.

MOTOR

While a one-quarter horse-power continuous service motor will do the work, the increased original and running cost, of a one-third or one-half horse-power motor is well worth the difference, as the one-fourth horse-power is very slow and noisy in starting.

A motor running about one thousand two hundred and fifty revolutions per minute is the best.

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Any gas, that liquefies under fifty pounds pressure, is suitable for use in the machine.

Sulfur dioxide is the most suitable for the machine and wallet. The cost of ten to fifteen pounds of this gas in steel cylinders is about a dollar a pound with cylinders included. (A refund is given for the return of cylinders.)

Ten to fifteen pounds will usually take care of an ordinary refrigeration box.

Twenty to thirty pounds may be needed for refrigerators on different floors.

NOTES

A jack or counter shaft may have to be used to get proper speed. Leaks will cause the most difficulty, so tighten each pipe as tight as possible the *first* time.

Keep the system absolutely air-tight.

If a leak should occur force all the gas either into the condenser or into the cooling coils and close the stop cocks between the units.

Another refrigerator may be placed in the system by simply using a second pipe leading to the other refrigerator as shown. Place the cooling coils and expansion (or needle valve) the same as in the other case.

The cost of material above is between one hundred and twenty-five dollars and one hundred and fifty, depending on how much must be purchased and the fluctuations of prices.

The cost of the running (upkeep) depends on the weather, the size of the refrigerator, and cost per kilowatt-hour.

If the switch is opened at any time, the refrigeration will cease in a few hours, but the minute the circuit is closed the operation will start up again exactly from where it left off.

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It will require some little work to get the system absolutely air-tight, but it must be done at any cost.

Disease Microbes Thrive on Paper Money

(*Continued from page* 311)

this process they receive a certain amount of friction, making the disinfection more effective. They are then fed into a second pair of belts and are dried by iron rollers heated by gas. Four thousand notes an hour is the capacity of this machine which is operated by two workmen.

Finally when they are too mutilated and dirty, they are destroyed by chemical process or by fire. The Treasury at Washington, cuts them into small pieces, and by maceration in a solution of caustic soda or potash reduces them to a liquid pulp. In France this method has long been abandoned and incineration has been substituted therefore. It is effected in a simple metallic retort, enveloped for the most part by a refractory coating. It is heated by gas and the product of distillation are conducted to the furnace. Fifty francs worth of gas will reduce to cinders, 15 million francs in 100 franc notes.

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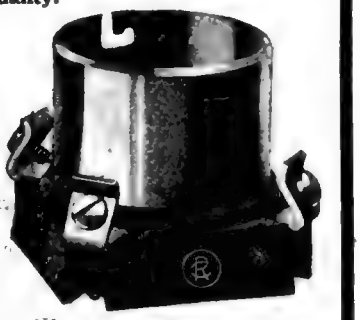

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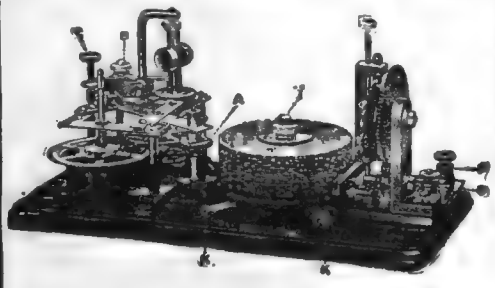

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Freak Phonographs

By H. JOHNSTONE

(*Continued from page 334*)

revolves. The writer simply suspended the shingle by means of a string passed thru a hole at one of its ends, as shown, with excellent results. The whole shingle vibrates and gives a remarkable reproduction, considering the crudity of the arrangement. A thin piece of hard wood, such as mahogany, should give fine results; the wood being about ¼" thick and measuring about 8x12". A visiting card or piece of Bristol board having a needle or pin, but preferably a phonograph needle, secured in one end by passing the needle thru two cuts made in the cardboard, shows quite surprising qualities of reproduction.

Today the radio amateur is afire with the idea of showing how good his wireless telephone station is, and he likes to send out phonograph concerts from his apparatus. To do this in the most efficient way requires a good microphone tone-arm. In Fig. 6 several suggestions are clearly shown which should be of value to radio and electric experimenters, who are desirous of converting the sound waves of the talking machine into electric current variations suitable for operating either a telephonic loud-talker, such as the Magnavox, or else for modulating or impressing upon a wireless transmitting set, the music given forth by the phonograph.

The microphone has been adapted to the phonograph tone-arm in several ways. We, first, show it mounted in the center of the tone-arm proper. Secondly, a substitute for this method, and of particular value where the experimenter does not desire to cut his tone-arm, is to place the microphone on one side of the wooden box, mounted just under the tone-arm, as shown at B. Fig. C shows how the equivalent of a four-button microphone tone-arm can be duplicated by the experimenter—the four microphones being mounted around the openings of the four sided wooden box, as illustrated. A wooden pyramid is placed in the bottom of the sound distributing box so as to evenly reflect the sound into each of the four microphones, the terminals of which are connected in multiple, so as to give four times the carrying capacity of one microphone, for use in loud-talker circuits, such as the Magnavox.

Fig. 6-D shows one of the best arrangements, one which is used in several commercial machines of this type for use with loud talkers, whereby the vibrations of the phonograph needle moving over the record are transmitted directly from the stylus to the diafram of the microphone. Practically any telephone transmitter or microphone can be used for this arrangement but a carbon diafram works the best, as was found by Mr. H. Gernsback in some experiments conducted in the laboratory some months ago. The upper end of the stylus arm is either attached with brass nuts or sealing wax to the exact center of the carbon diafram. Carbon diaframs can be purchased from any electrical or telephone supply house. Great care must be taken of course, in removing the old metal or mica diafram from the microphone when placing it in the sound-box chamber of the phonograph, so as not to spill the carbon grains out. If a home-made microphone arrangement is to be used, it will save the experimenter a lot of valuable time, to know that 90%, yes 95% of the results obtained with a home made microphone, are dependent upon the carbon granules employed. The best plan today is to buy small size well polisht carbon grains, which come in various gage numbers, They can be obtained from telephone or electrical supply houses.*

* On receipt of a stamped envelope we will gladly supply the names of several manufacturers.

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Airplane or Battleship—Which?

By Graser Schornstheimer

(*Continued from page* 309)

ubmarine campaigns and undeniably lose he war for them. As a result of their experience, the British, and the Japanese very evidently intend to follow their example, and will remove all submerged torpedo ubes from their warships. Now, add to he present disadvantages of the torpedo, he feature of its being dropt from a speeding lane into the water from the height of rom twenty to twenty-five feet, and you ave just about doubled its chances of issing the largest, best, and fairest target. his has been found to be true. However, he advantages of the torpedo-plane over the ombing plane are great enough, to provide n argument for its retention in the naval ervice.

Why the Battleship Is Still Supreme

As Secretary Denby said, "the battleship s still supreme." If she was not, why is it hat the British, who claim so much for heir aircraft, do not scrap their battleships nd concentrate their energies in air forces—nstead of building huge battleships as they re doing:

The answer lies in modern naval ordnance. Juring the war the British developed a orty-five calibered, 15 inch, naval rifle, ring a 1,950 pound shell, which has a range xceeding that of maximum visibility. This un was tried against the German forts on he Belgian coast, with great success, with he result that it was used in the arming of he famous "Hood," at present the most owerful ship in the British Navy.

How was it possible to fire a gun further han one could see with any accuracy?

In simple language, it was done by coup-ng the system of indirect fire with airplane potting. The gun was layed on the target t the range and traverse reported by air-lanes or other warships, and fired. No ne on the deck of the firing ship could see he target, but the airplane, which was unched from the crown of one of her urrets, could see the splash of the shell uite plainly. In fact, she could measure he errors in range and elevation at least well, if not better, than could the spotters the fighting tops of the ship, when firing a nearer target. The plane's *radio-elephone* makes communication with the ring ship quite simple, and the ship's unnery officer can quickly correct the range nd open fire again, smashing the invisible hemy to pieces with his big turret guns.

New tactics have been evolved because this great advantage. All warships of ny size carry one or two planes. Aircraft rriers, great mother ships with broods of lanes, are to be built by all nations. It is xpected that the United States will build wo. Japan has one under construction. he British have no less than six vessels of he type in service. Both the French and he Italians have the type represented in heir navies. While it is clear that America behind these nations, her aircraft carriers, hen complete, will be the best afloat.

All planes can be shot down. The war roved that *the best way to combat an airplane as with another plane.* Fighting planes to eep off enemy spotting, bombing, and tor-edo-planes have found their way into all avies. The first skirmishing of the future aval action will be between the air forces f the rival powers, when they wrestle for he control of the air. Air control will be he deciding factor in all future naval attles.

Bombing Tests on Battleship "Iowa"

Of course, other tests are to be carried out urther than those with the old predread-ought type battleship "Iowa." But these

(*Continued on page* 381)

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Glen—"I can call SPIRITS from the vasty deep."
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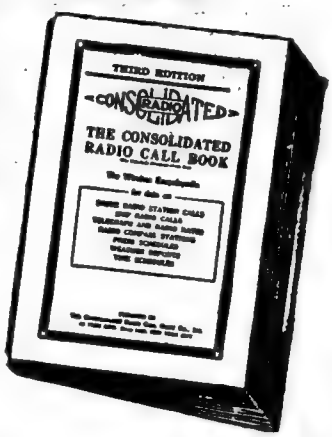

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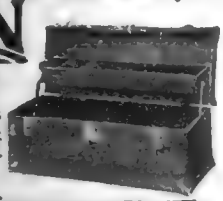

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Airplane or Battleship—Which?

(*Continued from page* 379)

tests will be the hottest contested and the most interesting. The "Iowa" is an old vessel of the Spanish War period, a famous ship of "Fighting Bob" Evans. She displaces slightly more than 11,000 tons and her speed was about 17 knots. The battery, which has been removed, consisted of four 12 inch and eight 8-inch short guns. She took a prominent part in the destruction of the Spanish fleet at Santiago de Cuba. Shortly after the close of hostilities she was placed out of commission and sent to the Philadelphia Navy Yard for conversion for these tests. All her guns and valuable equipment have been removed. The old triple expansion engines were left intact, but the coal burning boilers were removed and a lesser number of oil burning ones substituted. The decks have received additional modern protection, a plating of special heat-treated steel. The whole ship is now a vast wireless aerial, so perfect that it may receive radio-waves, under the most trying circumstances.

The wireless control instruments are placed far below the water-line in an especially protected position. It is said that three separate apparatus cooperated to do the work. One was for the control of the flow of oil from the tanks into the boilers, a second regulated the flow of steam from the boilers to the engines, and a third steered the vessel. The general idea of the control apparatus is the same as used by Mr. John Hays Hammond in his radio controlled boat, and in the German wireless controlled boat which attacked the British monitors off the Belgian coast. Mr. Hammond's boat was run, of course, with electric batteries, and the "Iowa" is propelled by steam. However, the same principle is applied in both cases.

It is expected that the "Iowa" will be experimented with for some time before being blown to pieces. First she will be controlled by another battleship, the "Ohio" which has been specially fitted for this purpose. A crew will go aboard the "Iowa" and get things started, leaving her when she is steaming down the bay and after control has been taken over successfully by the "Ohio." Under her direction, the "Iowa" will proceed further down the bay, where control will be taken over by a shore station and finally by an airplane. When controlled by an outside agency, the "Iowa" will have a speed of nine knots. After the electrical experiments are finished, the ship will proceed out to sea under control from the "Ohio." When in a known area 100 miles off shore, one hundred army, and eighty navy planes will commence a search for her. When she is found they will bombard her with dummy bombs from a height of 4,000 feet. After the bombing has been satisfactorily concluded, the ship will be visited and the number of hits carefully noted.

Then she will be a target for real bombs, and the results of these bombs against her protection will be carefully noted. It is expected that the planes will have to bombard from a much lower altitude in this test, in order to secure the very necessary hits.

A great deal of importance is attached to the results of these experiments because of the controversy between the Air Service and the Navy. It also has been said, that the "Iowa" will carry a sealed magazine of explosives on her last journey, and an attempt will be made to explode this magazine by wireless.

All the German warships will be used for experiments at this time. The "Frankfurt"

(*Continued on page* 383)

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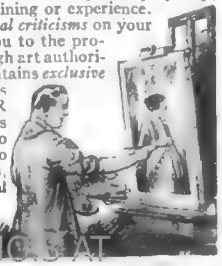

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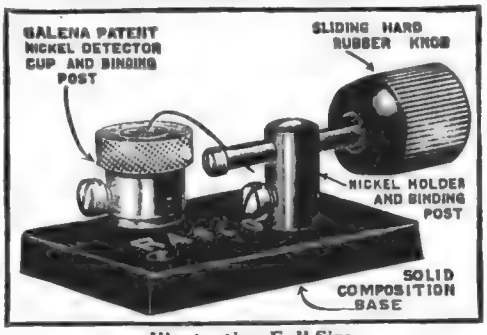
THE RASCO "BABY"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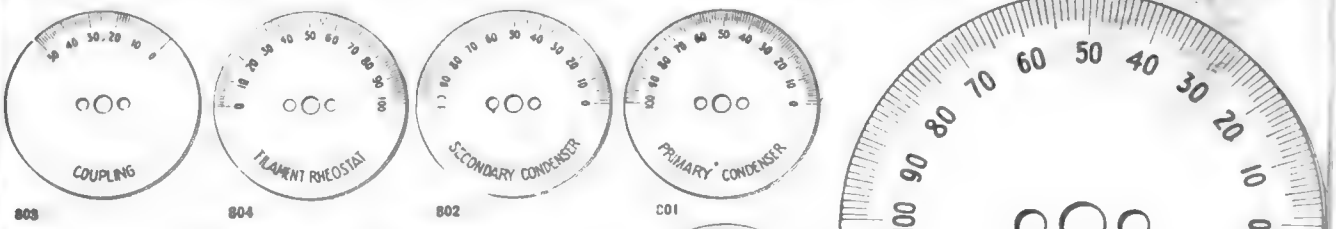

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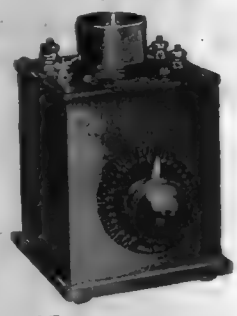

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Airplane or Battleship—Which?

(*Continued from page 381*)

is said to be the ship to make a test of poison bombs. Live animals will be on the ship's deck when the bombs fall. The submarines and destroyers will be bombed by aircraft, as will the battleship "Ostfriesland." Under assumed battle conditions, attempts will be made by destroyers to quickly locate and destroy some of the submarines.

Another interesting feature will be the bombarding by the fleet of the dreadnought "Ostfriesland." The "Ostfriesland" will be located at a definite point, and the fleet will start steaming toward her. Extra destroyers will put a smoke screen entirely around her and the fleet destroyers will completely cover the Atlantic fleet with a screen of smoke. At extreme ranges our battleship will open fire, their guns directed by airplanes launched from their turrets. This test will determine to a great extent as to how much dependence can be placed upon aircraft-spotting, under real battle conditions. It will also be especially valuable target practise.

The "Ostfriesland" is an exceptionally well protected ship. One of the best of the earlier German dreadnoughts, she has withstood severe punishment in the battle of Jutland, in which action she carried the flag of Rear Admiral Schmidt. The Germans were always great believers in the extreme protection of their ships, and they worked out their systems of armor placement with great pains. The results in this test should be extremely valuable in determining the value of high-angle fire and deck protection.

These tests are costing well into the millions, but the value of their results can not be calculated in money. The torpedo experiments alone will net us far more dependable information, than all our wartime experience, and they will settle disputes, which, if allowed to run on, would have cost a tremendous amount of time, money and efficiency.

Overcoming "Static" In Radio News Reception

By ARTHUR H. LYNCH

(*Continued from page 346*)

The cable editor of one large daily explained that his organization was getting the news out fast, and that there was a dire need for some constructive measures to facilitate the exchange of press reports, which, he maintained, were being greatly delayed. It was generally conceded, that it takes from five to seven hours to hear from London and seven to nine hours to hear from Paris. The reasons given for this delay were various forms of congestion of the business.

And all these reasons have contributed to lead the press to seek means of its own to secure the news with as little delay as possible. A large metropolitan daily has maintained a radio station for many months, for the purpose of intercepting radiograms addressed to it and its associates. One great saving of this system is that there is no delay in forwarding the message over the land wires from the commercial radio station, where it would ordinarily be received.

One of the greatest drawbacks to efficient radio communication, where great distances are involved, is the atmospheric disturbance known as static. It has been found that there are times when the static is of greater intensity in one section of the country than in another. This is especially true during the summer months, when this form of disturbance is most noticeable. Many

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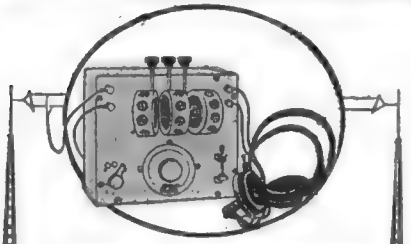

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instances have occurred where signals could be copied with little difficulty in one receiving station though they were entirely drowned out at another, a few hundred miles away.

The new development for receiving press news from abroad takes advantage of this irregularity by carrying on simultaneous reception at several stations, several hundred miles apart and connected by leased telegraph wires. In the near future, even the land wires are to be done away with and supplanted by radio stations of comparatively low power, which will be used for all manner of intercommunication between the receiving stations under a central control.

By arranging with the transmitting stations in Europe to transmit the press messages to the receiving stations in this country on a schedule previously decided upon and which will be best adapted to securing the news during the hours when the atmospheric disturbances are least pronounced delay in transmission will be offset. In arranging these schedules, attention is also paid to the time the paper goes to press so as to allow the news to be as complete and as fresh as possible.

Then, by consistent use of the land wires, where it is necessary to use them on this side of the water, there will be no delay in forwarding the news, caused by congestion of traffic, such as might be expected at the regular commercial receiving stations. When the conditions are good, even this overland transmission will be eliminated, and the messages will be received directly in the city where the paper is to be printed.

In dealing with the radio services of foreign nations, it has been necessary to secure the sanction of the governments, and the formation of the whole plan has taken many weeks.

A service of this character calls for apparatus of the most efficient design, because there are a number of stations which operate within almost the same electrical zone and tend to interfere with one another. When this interference is added to the interference caused by static, the task of receiving news from abroad becomes much greater. In order to overcome such interference, scientists have bent their efforts toward the development of some method of interference elimination.

At some of the large trans-ocean receiving stations there are systems in use for this purpose which are very costly and require great areas for their erection. For the time being it is thought that the press would not be interested in duplicating such expensive arrangements.

The system, which is now in operation in Philadelphia, with other contributing stations in Montreal and other cities, is making use of a new form of eliminator based upon an acoustic principle. By the proper manipulation of two converging cylinders an acoustic chamber is formed which corresponds to the tone of the incoming signal. The tone of the signal is very different in character from that produced by static, and the tones produced by any two transmitting stations are very infrequently the same, so that the acoustic method offers a very favorable field for segregation. This form of interference preventer may be installed in any station, because it is of small dimensions and is inexpensive.

In its entirety this news receiving development, which has been put into effect by L. J. Lesh, a former aeronaut, is the largest single enterprise of its kind ever established. A proof of the fact that it is of as great material benefit as it is spectacular may be seen, when it is considered that a dispatch from Europe was copied, printed and the paper was on the news stands before the message was received by the regular method.

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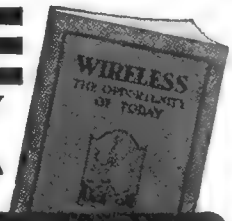

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Resonance Wave Coil Antennae

By J. O. MAUBORGNE and GUY HILL

(*Continued from Page 348*)

moved. In coils constructed solely for receiving the wire ordinarily used consists of about a No. 31 B. & S. silk covered copper wire.

In our earlier apparatus the lead from the coil went direct to the input grid terminal of the first stage of a suitable multi-stage amplifier, provided with the usual detector tube. In our first experiments no ground connection was made to the filament binding post of the amplifier; the simple circuit shown in Figure 2 was used in these earlier experiments. Stated in more or less popular terms, we found that we had a directive antenna of extremely small size, and that the only tuning needed to be done, was to

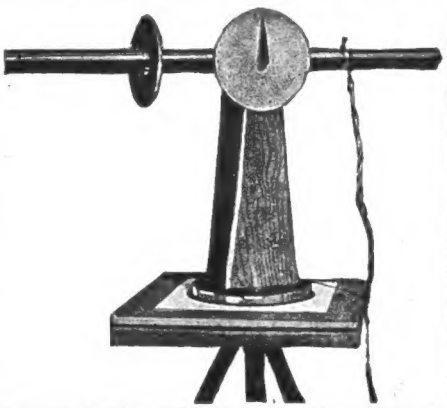

Fig. 1—Typical Small Size Resonance Wave Coil with Graduated Dial for Indicating the Angular Position.

shift the slider to various positions on the wave coil, whereby we changed the fundamental wave length to which the coil responded and received signals corresponding to such wave length.

It is possible for such a system to be in tune with one or two wave lengths at the same time, depending upon the position of the slider on the coil. The following diagrams will make this evident. With the slider at either end of the coil, as in (a) Figure 3, the wave coil is in tune for only one wave length, which is the longest one to which the coil can respond. With the slider at the center of the coil (b), Figure 3, it is evident, also, that we are in tune with only one wave length, since each half of the coil responds to the same frequency. With the slider at any other point on the coil (c), Figure 3, at unequal distances from its ends, we are in tune, simultaneously, with one short and one longer wave length.

(*Continued on page 387*)

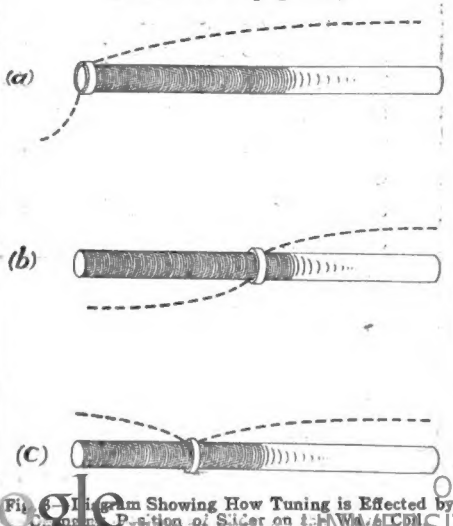

Fig. 3—Diagram Showing How Tuning is Effected by Changing Position of Slider on the Wave Coil

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Resonance Wave Coil Antennae

(*Continued from page* 385)

It will of course be entirely obvious to even the casual observer, that it is immaterial which of two positions one chooses for his slider in order to get the same wave length, for with a uniformly wound coil, in which we have uniformly distributed inductance, capacity and resistance, we may place the slider at a given distance from either end of the coil and still be in tune for the same wave length. It is to be noted, however, in this connection, that this gave rise to the early discovery, that the signals received on such a coil antenna, used horizontally, were not of equal strength for similar positions of the slider with respect to both ends, unless the turns of the coil were in the same plane, as that of the incoming signal, hence the directional qualities of such an antenna were early noticed. Another fact, very early observed, was that such a coil antenna, used vertically, afforded practically circular reception, and all directional characteristics of the coil disappeared when in such a position.

The extremely small size of a wave coil suitable for the reception of practical commercial wave lengths can be better appreciated from the following dimensions of a coil used for the reception of signals of a wave length of 1200 meters:

Diameter, 6¾ cms. (2.66 inch).

Length, 96 cms. (37.79 inch).

Wound with No. 32, B. and S., enameled copper wire.

Number of turns per centimeter, 36 (90 turns per inch).

It is to be noted that the wave length distribution on the coil remains true, only so long as the coil remains uninfluenced by a change in its terminal conditions, or by some change in the distribution of its capacity. In this connection it is to be noted, that should we make the simple addition to one end of the coil of a wire two feet long, extending in prolongation of the coil, the change in the position of the loops of potential corresponding to any particular wavelength, as well as the maximum wave to which the coil responds, is considerable.

One of the early advantages of the system, as above described, was found to be its sharpness of tuning, a movement of an inch along the coil often making a loud signal inaudible. The reduction of static was also found to be considerable, and in some cases, *practically all static was eliminated*. Grounding the filament gives slightly louder signals, but it is found, in practise, that many weak signals are drowned out, due to the static which is introduced when the ground is connected.

Later experiments gave another arrangement, as efficient as that described above. This consisted in employing a receiving set, provided with tuning elements, a feed-back circuit, and suitable detector and two-stage amplifier, as shown in the diagram in Figure 4. In this case it is essential, that the tuned closed circuit within the receiver, be adjusted to the same wave length as that determined by the position of the slider on the wave coil, and the characteristics of the portion of the coil between such position of the slider and one end of the coil. With a given intermediate position of the slider on the wave coil, it is possible to tune the receiving set, at will, to the wave found on either the longer or the shorter section of the coil. In this particular combination where the ground is not used, the primary tuning elements within the set, in series with the antenna, have practically no effect on the tuning of the wave coil antenna system, but simply serve to couple the antenna system to the tuned receiver secondary.

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